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The New Viceroy and Science.

WE have pleasure in offering our warmest felicitations and welcome to Lord Linlithgow whose appointment to the Viceroyalty of India is received with general satisfaction. His Lordship had exceptional opportunities intimately to study the political and economic conditions of this great country, and we hope that during his period of administration there will be peaceful and rapid progress in the achievement of the great ideals for which the nation is hungering. The problems which must immediately engage the attention of the new Viceroy must necessarily refer to the constitutional relationship of India with Great Britain, and probably the ceremonial arrangements connected with the Coronation of H. M. King Edward VIII in New Delhi. The successful inauguration of the New Reforms Act, arduous and difficult in itself, and the organisation of a historic pageantry, would under any circumstances entitle the Viceroy's administration to great praise; but the political, financial and economic developments, that have occurred in India since the introduction of Reforms in 1919, have so profoundly modified the outlook of the people, and have brought into existence conditions of life, that a solution of the more outstanding problems seems equally urgent. At the farewell dinner given by the Combined Empire Societies on the eve of his departure to India, Lord Linlithgow recalled his labours as Chairman of the Agricultural Commission and referred to unemployment, which together are fraught with possibilities far transcending in importance the issue of political evolution of this vast sub-continent. Few Viceroys have been called upon to assume the responsibilities of their exalted office in circumstances more critical than those which confront Lord Linlithgow, and the problems which await solution are not, however, beyond his statesmanship.

The welfare and prosperity of the people depend on the extent to which the country is scientifically organised, and our firm conviction is that unless the major industry of the people persistently applies scientific method and scientific knowledge to its problems, it cannot escape from the difficulties with which it is surrounded. In the field of science, therefore, no Legislature can reasonably recommend measures of economy which will sacrifice the efficiency of research

organisation. The Royal Commission on Agriculture have pointed out that "in spite of marked progress which has been made in many directions during the last quarter of a century, it is hardly an exaggeration to say agricultural research in this country is still in its infancy. The claims of research have received a half-hearted recognition and the importance of its efficient organisation and conduct is still little understood." On the recommendation of the Commission the Imperial Council of Agricultural Research was established, and in the beginning of last year, the Industrial Intelligence and Research Bureau was founded. By a judicious system of grants-in-aid and a careful selection of problems, the Imperial Council of Agricultural Research has promoted fundamental enquiries in agriculture in the universities and other research centres. The Industrial Intelligence and Research Bureau, which is attached to the Indian Stores Department, has, through its Advisory Council, formulated a series of problems in the fields of Chemistry and Engineering, for investigation at the Government Test House, Alipore. While we recognise the magnitude and the importance of work initiated by these bodies, we feel that the task of extending and consolidating national research activities could go steadily forward only under the auspices of a National Advisory Council of Scientific Research. There are now in Great Britain under the direction of the Department of Scientific and Industrial Research, 24 research associations in which the Department and industries co-operate, seven research institutions controlled and supported solely by the Department, which have been formed for the study of special industrial problems and 40 research stations dealing with agriculture or industry, some privately and some publicly controlled, whose function is to promote industrial developments. Many of these stations are connected with the universities of the country and receive subventions from Government. These are significant illustrations of what is going on over the whole of Europe including Russia, where scientific research is being intensively organised. It seems to us that simultaneously with the inauguration of constitutional reforms, an announcement should be made in regard to the establishment of the National Advisory Council of Scientific Research for the purpose of co-ordinating all the research organisations in order to promote a steady advancement of the industrial prosperity.

The principal task of such an institution will be to emphasise that no industry can afford in these times to neglect any opportunity for increasing its efficiency and, of all the means to this end, the pursuit of research and the applications of the results obtained are often the most far-reaching and fruitful. If the case for research on the production of Indian commodities is as strong as ever, the need for research into their utilisation is stronger still. In nearly every industry to-day, movements are on foot to apply old materials to new uses, and to discover uses for new material. Cotton, wool, rubber, food products and alloys of metals are instances in point. Whether the object in view be to create a wide demand for a commodity and thus reap the advantages of modern methods of production or to discover the most suitable material for a particular purpose, it is equally important that the chemical and physical properties of the materials concerned should be fully understood. For investigations of this kind, the facilities in the laboratories of the universities and in those of the Indian Institute of Science, if extended and supported by increased grants from the funds of the National Advisory Council of Scientific Research will be found ample for industrial research of the highest quality.

As part of the general policy of concentrating attack upon problems of immediate importance both to science and industry, Government should revise its scheme of award of subventions to research work conducted either under private or government auspices. The wider control which the Legislatures will soon acquire under the reformed constitution over the administration of public finance, will also provide increasing opportunities for the promotion of scientific research, without which Indian industries can never compete with the better organised European countries. The Government of India and the Indian Congress have individually launched a campaign for the welfare of villages and the betterment of village life, and large sums of money are proposed to be spent on the establishment of happier conditions in the village organisations. Almost every aspect of rural problem has a scientific bearing, and it must be obvious to any reflecting mind that scientific enquiry into conditions of villag

life should precede measures for their amelioration. Agricultural practice is only one aspect of rural science, which includes a veterinary side, animal and plant genetics, village economy and cottage industry, sanitation and water supply and building and road construction materials. The resources of governments and of other agents should not be fritted away by embarking upon empirical schemes of modernising villages, but should be devoted to the study of carefully planned investigations of the biological and economical features of the problems, on the results of which proposals of betterment should be based. Schemes for the improvement of villages will be permanent only if the rural population can appreciate their benefits, and if the individual members are sufficiently educated to support and improve the reforms. The rural commodities furnish the necessary materials for large-scale industries, and their continuous supply of the right kind involves a closer study of all raw goods by the producers themselves with such co-operation of the outside scientific expert as may be available. The village community must develop a scientific turn of mind before its welfare and prosperity could become the assured source of additional public revenue.

In reviewing the possibilities of developing rural science or expanding the industrial investigations, what emerges most clearly is the importance of provision for an effective programme of laboratory work in the Scientific Surveys, Universities, the Indian Institute of Science and Government Research Stations. In the laboratory the research worker is free from those obligations inevitable when experimental work on a large scale has to be planned, while intensive laboratory work affords the best way of understanding the root problems which may lead to improvements of relatively minor nature in the existing processes or to suggestions for alteration in production or in methods of utilising raw materials. One of the tasks of the reformed administration ought to be to foster close relations between laboratory work and industries, for on the extent of such co-operation depends the entire fabric of human civilisation. The most effective criterion of the value of laboratory research is the extent and direction in which the results are put into practice, but the application of the results is difficult to ensure unless industry is prepared to take a vital interest in the research work. The contact can become real and yield far-reaching benefits only when the new Legislatures recognise its superlative importance as a means of creating wealth, and provide in their annual budgets adequate grants for all private and public research institutions. The inauguration of constitutional reforms and their successful working may bring political contentment or may foster a new movement for further instalment of reforms, and the wisdom and public spirit with which they are brought into being, must also recognise that a decorated political vesture can only add to national dignity, but scientific organisation enriches and supports the life-blood of the country. The poverty and backwardness of India can be removed only by investing more money in the promotion of scientific research and if, in the midst of his political concerns and duties, His Excellency Lord Linlithgow could bestow some attention on the imperative need of consolidating the work of the Royal Commission over which he so worthily and ably presided, his contribution to the lasting happiness and prosperity of India would be such as few Viceroys have conceived or achieved. To watch and guide the working of the New Reforms Act is part of the routine programme of the Viceroy's duties, but to devise a scientific organisation of this great country "as a means of assisting the advance of the rural community towards a richer and fuller life, and of awakening the desire in that community for better things and arming each individual member of it against the temptations that beset him, without impairing either his self-respect or his spirit of manly independence," calls for the active and generous exercise of those higher qualities of statesmanship with which Nature and political training have abundantly endowed Lord Linlithgow.

The Physiology and Chemistry of the Plant Hormones.

By Kenneth V. Thimann.

(Harvard University, Cambridge, Mass. U. S. A.; formerly of California Institute of Technology, Pasadena, U. S. A.)

IT is now some 17 years since A. Paál published a paper in Germany on phototropic reactions in grass seedlings, and in the course of that time his results have led to the development of a new field in plant physiology. Paál set out to confirm the findings of Boysen-Jensen on the phototropism of the Avena coleoptile. Boysen-Jensen's experiment was to remove the tip of the coleoptile and stick it on again with gelatin; on subsequently illuminating from one side, phototropic curvatures appeared, not only in the tip but also in the part below the cut. It followed that the tip had some power of making the lower part of the coleoptile light-sensitive. In the course of his experiments Paál not only confirmed this, but also found that it was sufficient to replace the tip somewhat to one side to obtain a marked curvature away from the applied tip, even in darkness (see Fig. 1 *a*).

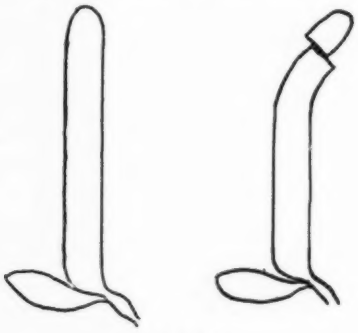


Fig. 1(*a*).

Curvature produced by unilateral replacement of tip.

Hence the tip promotes the growth of the part below it. This was confirmed in 1925, by Söding, who measured the straight growth with a travelling microscope; after decapitation the growth of the coleoptiles fell to a small fraction of its normal value, but on replacement of the tip it was increased. This experiment can only be carried out over short periods of time, since after about 3 hours growth increases spontaneously again; this is the so-called "regeneration of the physiological tip" by the uppermost part of the stump. This effect need not concern us here.

Stark attempted to extract the growth-promoting substance by crushing a number of tips and mixing them with gelatin or agar; the gel was then cut up and small pieces applied to one side of decapitated coleoptiles (Fig. 1 *b*). The results were negative.

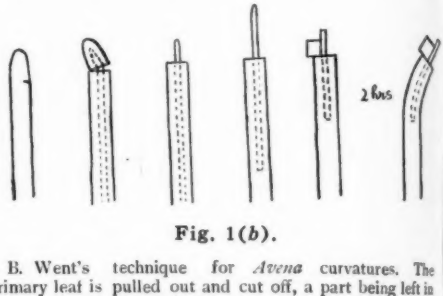


Fig. 1(*b*).

B. Went's technique for *Avena* curvatures. The primary leaf is pulled out and cut off, a part being left in as support for the agar block.

However, his student, Seubert, showed that blocks of agar containing saliva, diastase or malt extract, so applied, produced large curvatures in this way. Went (1928) then showed that if intact tips were placed upon agar, the growth-promoting substance diffuses out into the gel, which if now applied one-sidedly to decapitated coleoptiles caused marked curvatures. Instead of merely recording the number of plants curved he measured the angle of curvature and showed that, within limits, it was proportional to the number of tips which had stood upon the agar block. This enabled quantitative determination of the relative amounts of the substance present to be made, and this laid the foundation for subsequent work. On this basis Went determined that the amount of the substance produced per tip per hour remained constant for some hours. He also determined the molecular weight of the substance by the diffusion method, and found it to be 376, *i.e.* the substance is a relatively small molecule.

That a non-specific growth-promoting effect is here involved was shown by Cholodny, who placed tips of *mais* within a bored-out stem of *lupinus*; they promoted

its growth. Much subsequent work has shown that the action of the growth substance is completely non-specific within the higher plants.

Cholodny put forward the theory that if the growth of the coleoptile was due to a growth-promoting substance, then its *asymmetric* growth must be due to an asymmetric distribution of this substance. In other words, curvatures such as those exhibited in phototropism and geotropism must be caused by the active substance becoming concentrated on one side as a result of the action of the light or gravity. The truth of this view was proven experimentally by allowing the substance to diffuse out into separate blocks at the base of the coleoptile; Went showed that on unilateral illumination more growth-promoting substance came from the shaded (S) than from the lighted (B) side;—correspondingly the plant curves *towards* the light; Dolk (1930) found that on placing the coleoptile horizontally more growth substance came from the lower (L) than from the upper (U) side; (see Fig. 2). The essential mechanism of

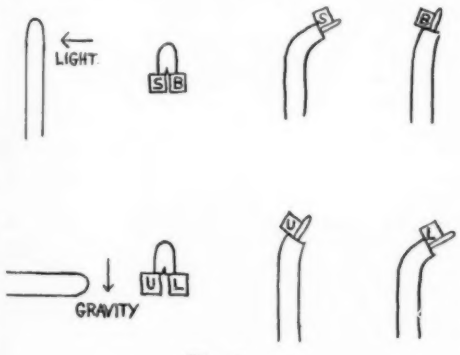


Fig. 2.

Asymmetric distribution of growth hormone in tropisms. The shaded side S, and the bright side, B, are allowed to diffuse into separate agar blocks. The former gives the larger curvature in the subsequent test. With gravity the upper side, U, and lower side, L, are similarly treated; the latter gives the larger curvature subsequently.

geotropic and phototropic response is thus explained, though the latter is complicated by the "light-growth reaction" of Blaauw. The various factors in phototropism need not be discussed here, for they have been reviewed in detail by du Buy and Nuernbergk (1932–35).

The use of Avena curvatures as a standard test for growth-promotion depends upon the fact that curvature is proportional to the concentration applied up to a certain limit,—the "maximum angle", which is usually about 20°; similarly in straight growth the growth produced is proportional to the concentration applied bi-laterally within somewhat wider limits, but here too there is a maximum concentration above which there is no further response (see Fig. 3, from Thimann and Bonner, 1933).

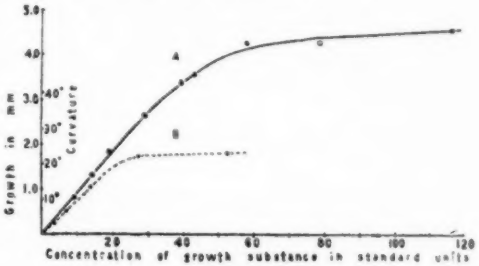


Fig. 3.

Amount of growth resulting from different quantities of growth substance.

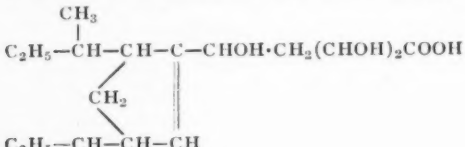
Curve A, vertical growth; curve B, curved growth.

The next step, of course, was to discover the chemical nature of the active substances or hormones. Nielsen, in 1930, made the first step towards this by finding that the medium on which certain moulds had grown was rich in a substance promoting coleoptile growth, and that the substance was soluble in ether. Dolk and Thimann (1931) made large-scale preparations of the substance from mould cultures, and found that it was extracted by ether only from acid solutions, *i.e.*, the substance is itself an acid. By shaking out at different pH the dissociation constant of the acid was determined as $1{\cdot}8 \times 10^{-5}$, *i.e.*, about that of acetic acid. The sensitivity to H_2O_2 and other mild oxidising agents indicated the substance was unsaturated. The limiting detectable curvature was found to be produced by 7×10^{-6} mg., of the concentrated syrup.

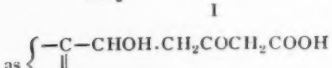
The same growth-promoting action was also found in human urine by Kögl, Haagen-Smit and Erxleben (1931, 1933), and from the ether extract of acidified urine they succeeded in crystallising an acid, $C_{16}H_{32}O_5$, m.p. 196°. It formed a lactone, which is also active, and contained a total of 3 OH groups; the molecular weight, 328, agrees satisfactorily with that found by Went for the substance in the coleoptile tip, but of course this does not prove the identity of the two

substances. From malt and from maize germ oil was isolated another acid, $C_{18}H_{30}O_4$ *i.e.*, isomeric with the lactone above. The breakdown experiments of Kögl and his collaborators have shown that the former substance, "auxin A, or auxentriolic acid", has formula I, while the other, "auxin B, or auxenolonic acid" is the corresponding β-keto-acid, formula II.

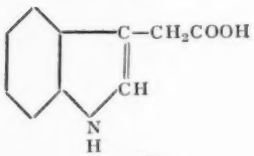
However, many other substances possess the same growth-promoting activity. Kögl and co-workers found that a large part of the activity of urine was due not to the above "auxins", but to a third substance, indole-3-acetic acid (formula III), a substance known as a product of bacterial breakdown of proteins. This acid is highly



I



II

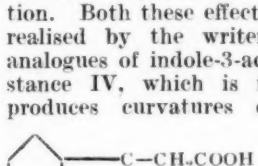


III

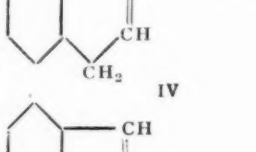
active; in terms of curvature on *Avena* under standard conditions its activity is from 50–70% of that of "auxin A and B"; of the latter a curvature of 1° is produced by the application in agar of $2 \cdot 10^{-8}$ mg., an extraordinarily high activity. The writer has shown (1935) that the growth-promoting substance produced by mould cultures is also indole-3-acetic acid. It is formed principally in the presence of peptone, and the yields depend upon the tryptophane content of the peptone; they also vary with the aeration given to the culture, since conversion of tryptophane to indole-3-acetic acid is an oxidative process. Kögl and Kostermans have tested the activity of a number of derivatives of indole-3-acetic acid and many of them are active, though none has more than 20% of the activity of the mother substance.

Before discussing other developments in this direction it is necessary to consider the nature of the growth-promoting action. If the substance is applied to the apical end of a section of a coleoptile, it is transported rapidly to the basal end, and may be found there if an agar block be applied to the basal cut surface. If, however, conditions are reversed and the substance is applied at the base, none appears at the apical end. The phenomenon is independent of gravity. This very remarkable polar transport was studied by van der Wey (1932, 1934) who showed that it is reversibly suspended in presence of narcotic vapours. Similar polarity exists in young bean and pea stems and other research material. The combination of this concept of polarity with the unilateral transport which occurs in tropistic growth or when the growth substance is applied to one side only gives a picture of the normal transport as a strictly "apex to base" affair; any molecule, whatever its position, will be carried towards the base, not across or up the plant, independent of gravity or of the gradient of the growth substance.

Clearly, if a substance applied in agar were to spread out across the plant it would produce no curvature, even though it might promote the growth. If it did not spread out, but was transported less rapidly than the naturally-occurring growth substance, it would produce a curvature, but only for a short distance below the point of application. Both these effects have recently been realised by the writer (1935), with two analogues of indole-3-acetic acid. The substance IV, which is indene-3-acetic acid, produces curvatures only over a short



IV



V

distance (see Fig. 4), while substance V, coumaryl-1-acetic acid, produces no curvature at all; both promote growth of *Avena* strongly, however, as tested by straight growth, although they are not as active as

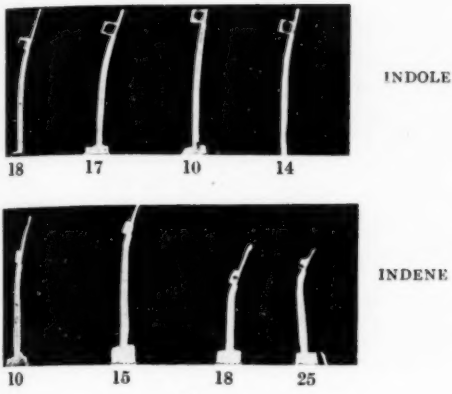


Fig. 4.

Curvatures caused by indole-acetic acid, readily transported, compared with localised curvatures due to indene-acetic acid, poorly transported.

compounds I, II and III ; they also produce growth and curvature in pea stems. It is clear, therefore, that we must distinguish between growth-promoting action as such and the faculty of being transported in the plant, and compounds may possess one property without the other. These considerations open up new possibilities for investigating the mechanism of the action. It is interesting to note that Went and Haagen-Smit have recently tested a large number of other compounds for growth-promoting activity, and have found some other compounds which behave like the two above. Thus atrolactic acid, like V, does not produce *Avena* curvature although it promotes straight growth, while allocinnamic acid resembles IV in producing a curvature which is limited to a small zone close to the point of application.

The fundamental problem of the mechanism of the action of the hormones, while it may perhaps be approached by chemical methods making use of compounds like III, IV and V, is still very far from solution. The work of Heyn has shown that coleoptiles, and some other suitable objects like tulip-stems, become more plastically deformable if they have been first treated with auxin.* A rider placed upon a coleoptile causes a greater degree of irreversible bending in presence of auxin than without it, and the response of decapitated coleoptiles increases after regeneration of the physiological tip. Hence one effect of the substances is to increase the plasticity of the tissue, and this presumably allows osmotic forces to stretch the cell-walls irreversibly. Even if this view is true,—and it is still in dispute,—the difficulty remains that the number of molecules of auxin entering the tissue is far too small to have any stoichiometrical relation with any of the wall constituents. The data of Thimann and Bonner show that one molecule of indole-acetic acid gives rise to the formation of 3×10^5 hexose units as cellulose, and a correspondingly large number of pectin, protein, hemicellulose and other molecules. In order for auxin to have its effect, the tissue must be respiring ; Bonner showed that if respiration be partly inhibited by HCN, growth is inhibited to the same extent. An oxidative process is therefore involved in growth. Another interesting fact is that the auxin disappears in the growth process ; within limits the amount disappearing is proportional to the growth produced, but if excess is applied most of it is destroyed in the tissues without causing proportional growth. Since it disappears also in presence of HCN the disappearance cannot be by the oxidative reaction mentioned above, and must hence involve yet another process. It is thus clear that the reaction in which auxin takes part is only the first of a chain, the last member of which may cause the increase in plasticity and so give rise to growth.

It will now be necessary to digress somewhat. It was the view of Sachs that the various organs of a plant are each formed under the control of a special substance, and the classic experiments of Vöchting showed that root formation in particular is a polar phenomenon, roots being mainly formed at the morphological base of a cutting. The exceptions which form roots all over have ready-formed root initials, and apart from these Van der Lek's (later) experiments show that roots are formed in a strictly polar manner, and largely under the influence of buds and leaves. These phenomena strongly suggest hormonal action, and Bouillene and Went proved that a substance of some kind is really involved because water in which leaves had stood possesses root-forming activity. Commercial diastase has the same effect. The nature of this root-forming hormone was studied by Thimann and Went ; it was found to have all the properties of the auxins ; on purification

* The term is used in a general non-chemical sense as 'growth substance'.

the growth-promoting activity followed parallel to the root-forming activity ; finally they showed that pure auxin A and B and indole-acetic acid are tremendously active in forming roots, only 10^{-5} mg., being needed to form 1 root on the pea stems used. Laibach and co-workers also found pollen and urine, rich sources of growth substances, to have root-forming activity. These compounds, I, II and III, therefore, give rise not only to growth by cell extension but also to root formation,—two apparently unrelated physiological processes. Root formation usually begins with cell divisions. Root formation, like growth promotion, seems to be highly non-specific, peas, beans, lemons (see Fig. 5), marigolds, figs, *tradescantia*,

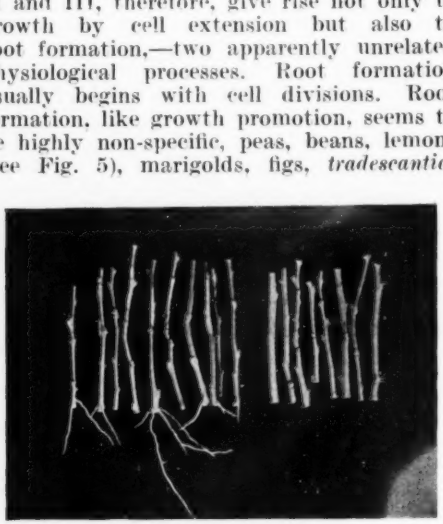


Fig. 5.

Leafless lemon twigs; left, treated (indole-acetic acid in lanoline) ; right untreated. After one week in moist sand. (Courtesy of W. C. Cooper.)

acalypha and *nicotiana* all respond well ; the use of hormones for rooting of cuttings may therefore be of practical importance. Of course, since the hormone is produced in leaves and buds their presence will, in general, facilitate rooting also.

If these compounds are applied in rather high concentrations to a decapitated plant they produce a marked swelling which may comprise both enlarged cells and also new cells formed by rapid division, especially of the cambium. In 1933 Snow showed that the activation of cambium, which Jost found long ago to be due to the influence of leaves and buds, is due to a hormone which can pass across a discontinuity. Subsequently he found (1935) that auxins A and B and indole-3-acetic acid stimulate the cambium, and that the action is exerted at about the same concentrations of growth substance as normally exist in the plant. The postulated "cambial hormone" is thus the same as the other hormones.

Another aspect of these multifarious activities was brought to light earlier by Thimann and Skoog (1933, 1934) and was in fact the first proof that these substances have more than one function in the plant. It had been made very probable by Snow in 1925 that the inhibition of the development of lateral buds in a herbaceous plant by the terminal bud is due to some inhibiting substance which can diffuse across a dead stretch of stem. In our experiments it was found that in *Vicia faba* the terminal bud produces large quantities of growth substance, while young undeveloped buds, which do not inhibit other buds, produce practically no growth substance. It was therefore suspected that the postulated "inhibiting substance" was identical with the growth substances. This was proven by applying the growth-promoting substance obtained from mould cultures (since proven to be indole-acetic acid) to decapitated plants, in concentrations comparable to, or somewhat higher than, those obtaining in the plant. The buds were completely inhibited in their development (see Fig. 6).

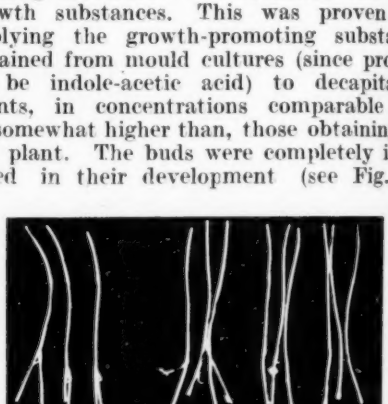


Fig. 6.

Bud inhibition on etiolated pea seedlings after decapitation. Left to right; 2·5, 0·6, 0·15 mg. Indole-acetic acid per gram of lanolin, and untreated controls respectively. Note also the marked swelling produced by the highest concentration. Growth of main stem is about the same in all four groups.

Later work showed that here again auxin A and B and indole-3-acetic acid were all highly active. It may be mentioned here that Nielsen found that roots are also inhibited in their growth by auxin preparations ; subsequently all three of the above substances have been found to have this effect. Root inhibition may even be used to

some extent as a test for auxins. Thus the initiation of roots is stimulated, but their growth retarded, by the substances.

All this work shows that the same compounds are responsible for a large number of activities in higher plants, involving cell extension, cell division, and processes of differentiation and inhibition. Are all these phenomena due to the same primary process? *A priori*, it seems unlikely that one cause could start so many processes. Nevertheless, the evidence indicates that it is so. The writer has shown that those other substances IV and V, which partially imitate the action of the auxins I, II and III, also cause initiation of roots, inhibition of root growth and inhibition of bud development. They are limited in their action by being poorly transported, but the activity is there. Other substances are under study. Thus it is probable that any compound which brings about one of these effects has the power to bring about all of them, provided only that it is not prevented from doing so by failure to be transported, or by other limiting factors, such as water for cell extension or sugar for root formation. Thus we reach the view-point that the auxins and the other related active compounds (all of them unsaturated organic acids or easily hydrolyzable esters) exert some kind of general stimulation on the cell. The subsequent observed response depends on the condition, nature and anatomical position of the cell. The cells in young tissues may increase in size; older cells may not do this, but some of them respond by division, those in the parenchyma between bundles giving rise to cambium, those in the pericycle giving rise to root initials. The inhibition of bud development and of root growth, however, are not explained by this or any other satisfactory view at present. The rôle of other factors together with the above hormones may prove of great importance.

In conclusion it may be said that not only has knowledge of hormones thrown much light on some aspects of plant physiology, but it has also given us a new set of tools for the study of genetics, morphology and problems of development.

References to literature will be found in the recent documented reviews of Snow,[1] F. A. F. C. Went,[2] F. W. Went,[3] Jost[4] and Thimann.[5]

[1] *New Phytologist*, 1932, **31**, 336.
[2] *Biol. Rev.*, 1935, **10**.
[3] *Botan. Rev.*, 1935, **1**, 162.
[4] *Zeit. f Botanik*, 1935, **28**, 260.
[5] *Ann. Rev. of Biochem.*, 1935, **4**, 545.

Animal Husbandry in India—Retrospect and Prospect.

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ANIMAL Husbandry may be defined as the art of producing, maintaining and disposing of the different species of domestic animals and poultry in the best possible manner for those uses which man requires of them, and, in the same way as the scientific method is now considered essential for progress in most other walks of life, so in this subject it is necessary to remember that any contemplated development should be based on the three sciences of veterinary medicine, animal nutrition and animal genetics. The analogy of Animal Husbandry amongst the livestock population to Public Health amongst the human population will thus be seen.

As Indian Agriculture is so dependent on its cattle throughout its activities, there has been a tendency to think only of these animals when talking of Animal Husbandry and to look upon this art as being connected only with the processes of crop and milk production, but, as will be seen from the definition above and from what follows, Animal Husbandry work covers a much wider field. For this reason it is suggested that India could not do better than follow the lead of other progressive agricultural countries, which make a point of using the word "Agriculture" in its widest sense in official correspondence, and adopt the terms Plant Industry and Animal Industry to describe the two great divisions into which the subject can be divided.

To ascertain the value of India's major livestock industries a survey was carried out by Colonel Olver, Animal Husbandry Expert, and Rao Bahadur Vaidyanathan, Statistician to the Imperial Council of Agricultural Research, and we are now able to allot them an approximate figure. It will probably surprise many to learn that this figure,

even at a very conservative estimate, slightly exceeds the value of her cash crops. The original estimations were based on prices ruling in September 1929, and assuming that there has been a drop in prices of 33% since that date, we arrive at the following figures for the different items which go to make up the enormous total :—

	Crores of rupees
1. Milk and milk products ..	540
2. Cattle labour in agriculture ..	408
3. Manures	180
4. Labour for purposes other than agriculture	107
5. Other products such as hides and skins, meat, wool, etc.	30
6. Live animals exported ..	0·12
	1,265·12

It will be seen that such items as the inland trade in livestock and profits from horse, poultry and pig breeding and other minor industries, have been excluded from the calculations, owing to the difficulty of obtaining even approximate figures of their value at the present time, but there is no doubt whatever that if they were included the total would exceed Rs. 1,300 crores *per annum*, a sum sufficiently large to justify the plea that is being made for the exploitation of this industry on more scientific lines.

The Government of India early recognised that the welfare of India's livestock largely depends on the control of contagious disease and set up as long ago as 1890 what is now the Imperial Institute of Veterinary Research, Muktesar, for the investigation of these ailments and the preparation of agents for their control. That it has more than justified the money that has been spent on it cannot be refuted, for a number of those conditions with which it was originally charged to deal, notably Rinderpest in cattle and Surra in horses, are now well under control, provided that the requisite amount of field staff can be made available. The cause of a large number of other conditions has also been elucidated, and in this connection it is noteworthy that the Royal Commission on Agriculture in 1927 observed that scientific research into these matters appeared to be progressing at a quicker rate than executive staffs were able to take advantage of it, and the position has not improved greatly in this respect since that report was written. One realizes that the provision of more fully trained veterinary field staff by the Provinces and States is a matter of considerable difficulty in these days of restricted revenues, and the only solution appears to be the training of a cheaper agency. In other countries stockmen are employed in Animal Husbandry departments to carry out the duties of vaccinator, castrator, etc., under veterinary supervision. It is particularly desirable that protection on a large scale should be made available for the control of Rinderpest, by far the most destructive cattle plague in India, for in the recently adapted goat virus, which can be used alone as a vaccine on all country cattle and even on cross-bred calves up to the age of 18 months, we have a simple, efficient and cheap product, which should prove a most powerful weapon, if properly used, not only for the control of the disease, but also for the automatic improvement of cattle by using it to save the valuable animals, when time and money will not permit of its application to the worthless ones.

Next in importance in Animal Husbandry work to the control of contagious disease is the question of Animal Nutrition, and we have had small sections working for some years on this subject at the Imperial Institute of Animal Husbandry and Dairying, Bangalore, and the Agricultural Colleges at Coimbatore and Lyallpur. More recently, a small staff has been financed by the Imperial Council of Agricultural Research and attached to the Agricultural Chemist's Laboratory at Dacca, so that local investigations are now being carried on in several typical parts of the country. These include the analysis with digestibility trials of a number of grains and fodders in common use in India, and it is important that this work should be continued. In addition, more fundamental work connected with the maintenance of animals in India in the optimum state of health requisite for the duties they have to perform, whether this be work, production of milk, wool or other articles of trade, and to increase their resistance to disease, is required and as a result of a grant from Government facilities for this will be provided at the new Animal Nutrition Section which is being added to the central organisation for Veterinary and Animal Husbandry Research at Izatnagar, a sub-station of Muktesar.

Undoubtedly the outstanding scientific

problem in India to-day is one of nutrition and it is one for the solution of which the best brains amongst workers in crop production, human nutrition and animal nutrition will be required. India's human population is increasing by leaps and bounds, her animal population is much larger than it should be, and in both cases there is already a vast amount of mal-nutrition prevailing. The ideal state would be for the plant breeder to show the ryot how he can produce larger and better crops for his own consumption, so releasing some of the land for the production of fodder crops for his animals, which in turn should produce more milk and other products for his household or for sale, and better manure for his land. It will be a very long time, however, before such an ideal is attained in India and in the meantime animal husbandmen must endeavour to alleviate the situation in other ways. The most promising line appears to be the better utilisation of forest grazing areas for the rearing of young stock, and this, of course, is a matter which cannot be dealt with satisfactorily without the co-operation of the Forest Department, but given this and the closest possible cohesion between Livestock and Veterinary officers, it should be possible to arrange for these areas to be more effectively used and for them to rear better cattle, which should find their way to those parts of India which are unable to provide the fodder necessary for young growing cattle.

The Governments of India, both central and provincial, and their advisers took action many years ago to remedy some of the most obvious causes of the degeneration of cattle in India by establishing cattle farms for the production of breeding bulls of known pedigree and in some cases to preserve a breed from extinction. Some of the best examples of these are the Hissar farm in the Punjab for the Hariana breed, the Chharodi farm in Gujerat for the Kankrej breed and until lately the Madras Government maintained the Chintaladevi farm for the Ongole breed, the animals of which are in great demand for export to other tropical countries. Unfortunately, during the recent financial depression, this latter farm was closed as a measure of retrenchment.

The Central Government in this matter have devoted themselves mainly to the question of maintaining and improving some of the best milch breeds in India, and the Sahiwal herd at Pusa, the Scindi herd of the Imperial Dairy Institute at Bangalore and the Tharparkar herd at the Imperial Cattle Breeding farm at Karnal will ever remain a testimony to their foresight.

It cannot be expected, however, that the different Governments will always be prepared to undertake the whole of the work that is necessary for the maintenance of pedigree herds of India's many breeds of cattle, to which buyers both from inside and outside the country can go for their requirements, and it is to be hoped that more land-owners will follow the good example of the Pattakar of Palayakottai, who keeps a pedigree herd of Kangayam cattle near Coimbatore in the Madras Presidency, and maintain similar herds of the breed indigenous to the tract in which they live. These should, if required, prove a source of profit to the owner, and they can be used for the production and distribution of breeding bulls to the surrounding villages.

When all is said and done about cattle farms, however, we are still faced with the position that they can do only a small part to help in the general improvement of the cattle of this great sub-continent, for which more intensive work in the villages by those qualified to give advice is the only solution. The most important items are the introduction of controlled breeding with specially selected or herd-book sires, in the manner recently initiated in the Punjab and the Bombay Presidency, the castration of all unsuitable males, and propaganda work on the general feeding and care of animals, particularly the young.

In addition, India should now consider the desirability of following the example of other progressive agricultural countries which have set up organisations for the study of applied animal genetics, where investigations can be carried out into such subjects as the inheritance of milking and working qualities, wool and egg production, disease resistance factors, etc., technical breeding processes like artificial insemination, and sterility, particularly the partial sterility from which so many Indian cows suffer and which has to be removed before the cattle population can be reduced to figures more commensurate with the available food supply.

There still remain the side-lines of Animal Husbandry such as commercial dairying, poultry keeping, sheep and goat breeding, horse-breeding and the cottage industries of silkworm-rearing and bee-keeping, which

to-day are usually included under this head. Of these, the Dairy industry is by far the most important to India, even judged by figures alone, but apart from this is the fact that milk and its products will supply the animal protein and fat which are so necessary for the proper nutrition of a human race whose diet is predominantly vegetarian. It is a matter for gratification, therefore, that at the instigation of the Imperial Council of Agricultural Research, the Government of India have recently allotted a sum of Rs. 6 lakhs, which is to be devoted to improvements to the Imperial Institute of Dairying at Bangalore and the re-opening of the Anand Research Creamery, which will be staffed and equipped with the primary object of devising the best methods for the collection, preservation and transportation of village milk to the big cities of India. This work, if successful, should at one and the same time improve the lot of the villager, provide the town dweller with more of the food he requires at cheaper rates, and save from slaughter many specimens of India's best milch breeds, which to-day are brought into the cities in large numbers and destroyed after one lactation.

In order to help the Poultry industry, it has also recently been decided by Government to add a Poultry Research Section to Izatnagar, where investigation into Poultry diseases and different industrial processes will be undertaken side by side.

This new movement for the better development of Animal Husbandry in India has been set in motion chiefly through the efforts of the Imperial Council of Agricultural Research and should act as a great stimulus to workers in veterinary, dairy and their ancillary sciences. Very little work connected with domestic animals has been undertaken at the Indian Universities up to the present, but they are admirably suited for the investigation of some zoological subjects, such as the identification and life-history of ecto- and endo-parasites, certain physiological problems, the analysis of local fodders and grasses, etc. It is to the Veterinary profession in India, however, that the prospect should make the greatest appeal and it is to be hoped that its members, and particularly those responsible for devising the curriculum for the Veterinary graduates of the future, will see that the profession is fit to take its proper place in this new campaign.

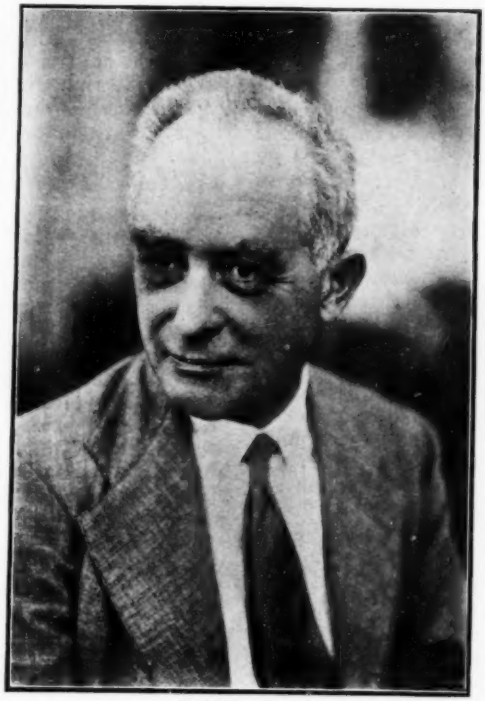
So far the main object of Veterinary courses in India has been to teach the control of disease, but the endeavour of Veterinary Colleges in all other parts of the world to-day is to turn out, not merely a man well-versed in that subject, but one who also understands animals at all stages of their existence and is able to get the best out of them, *i.e.*, the complete animal husbandman. When the Royal Commission on Agriculture was discussing the best type of officer to employ on cattle breeding farms it remarked that "when the knowledge and instincts of the farmer and cattle breeder are combined with the professional training of the Veterinary Surgeon the position is ideal".

Another great authority, Sir Daniel Hall, late Scientific Adviser to the Ministry of Agriculture in England, in a recent lecture stated "I see the task of the people who are dealing with the health side of animals to be, in future, very much more hygienic and the maintenance of health than the cure of disease. What I would like to see is a class of Veterinarians who are officers of animal health rather than practitioners. There must always be practitioners who are concerned with surgical cases and with specific illnesses of valuable animals, but it seems to me that the great efforts of the profession should be rather of a public nature. Instead of being called in to this ailing cow, or that fretting horse, we want to see a class of men who have charge of a district, who are thinking about the horses, the cattle, the sheep and the pigs and how to keep disease away from them. Naturally, they will have to know about the endemic diseases, but breeding, environment, nutrition, and other factors in hygiene will be equally important. I think that is going to be the direction in which the Veterinary profession itself will eventually move, and that the veterinarian of the future will be the kind of public officer who is taking prophylactic and preventive measures and who is studying problems like nutrition and so forth, so as to ensure a greater amount of health amongst the animal population."

If the teachings of these authorities are followed, then there should be evolved a class of livestock officer for service in India who is able to take full advantage of the encouragement and help now being given by Government and we may look forward to a great future for Animal Husbandry in India.

Prof. Max Born.

PROF. BORN arrived in Bangalore on the 24th September 1935 and left it again to Cambridge on 18th March 1936, having been in residence at the Indian Institute of Science for a period of six months. His main work during this rather short period was the delivering of a course of lectures on optics. This general course, which was attended by the students and members of staff of the Physics and Mathematics Departments of the Institute and the Central College, consisted of nearly 25 to 30 lectures on molecular optics, on the quantum theory of radiation and on the recent neutrino theory of light. In addition to these general lectures, a set of about a dozen lectures were delivered to a special batch of students on the new field theory. Prof. Born also took constant part in the usual weekly Monday seminars at the Institute and was a source of inspiration to workers in different branches of experimental and theoretical work. During this short period, Prof. Born also delivered about half a dozen public lectures where he showed that he was a great master in the art of making the results of abstruse scientific thought popular to the lay public. Prof. Born also had, working under him, students dealing with problems on the Kristalgitter theorie, neutrino theory of light, unitary theory of field and matter and optical activity.



Prof. Max Born.

It is amazing to speculate how profoundly a great scientific mind can influence those coming in contact with it. A most eminent physicist alike in the depth of physical insight and the breadth of mathematical power, a most lovable personality with a fine sense of humour and a teacher whose encouragement and kindness to his students is perhaps unparallelled — these are some of the traits that strike any one who has come into constant contact with Prof. Born. The one thought uppermost in the minds of his students and admirers is that it might be possible for him to come again to Bangalore and stay for a longer period.

B. S. M.

A Preliminary Survey of Marine Boring Organisms in Cochin Harbour.

By Eileen Whitehead Erlanson, PH.D., D.SC.

MARINE boring organisms destructive to shipping, particularly the Shipworms (Teredinidæ), have been mentioned by writers from early times. The first careful scientific study was made in the eighteenth century when timber in the dykes of Holland was badly attacked by shipworms, and a detailed treatise on their anatomy and habits was published by Godfrey Sellius[1] in 1733. Since then several accounts of these specialised molluscs have appeared and a multitude of species have been described differing in minor morphological characteristics. No modern biological survey was undertaken in any region until the wooden piers and jetties in San Francisco Harbour were invaded by shipworms and collapsed twenty years ago. The resulting report by Atwood and Johnson[2] which was sponsored by the National Research Council describes methods of attack which were followed in this present study. After the World War the Institute of Civil Engineers, London, also initiated a survey of marine borers, with Dr. W. T. Calman as technical adviser.[3] Specimens were sent in by members from all over the world, but these were mostly pieces of damaged wood. The British Museum has also published a very helpful bulletin by Dr. Calman.[4]

Late in 1934 it was discovered that there was only one specimen of molluscan borers in the British Museum from India. Crustacean Isopod borers from the East were also not well represented in London nor in Museums in India. With the exception of the shipworms the taxonomy of marine boring organisms has received scant attention in spite of the economic interest. It is with a view to stimulating the interest of Indian scientists in these fascinating creatures that this report is published. I am indebted to C. W. Knight, Esq., for help with the Survey, and to Dr. I. Gordon of the British Museum for identification of the Crustaceans. She could only give tentative specific names and states that Indian material should be studied further and that the Cochin specimens differ somewhat from type descriptions.

COCHIN HARBOUR.

The opportunity was taken in 1935 to make an initial survey of the marine borers in the waters in and about Cochin Harbour, Malabar Coast, South India. This is a fine natural harbour, cut off from the Arabian Sea on the west by long low sandy spits between which there is a single narrow gut some 1,500 feet wide. To the north and south the harbour is continuous with hundreds of miles of shallow brackish lagoons called Backwaters which stretch into South Malabar, Cochin State and Travancore, and receive the waters of several large rivers from the Western Ghats.

Cochin Harbour lies at about 10° North and receives the full benefit of the south-west monsoon, as well as some precipitation from the north-east monsoon from October to December. The annual rainfall is 120 inches, more than half of which falls in the four months from June to September. During and right after the south-west monsoon the water in the backwaters, and even on the Cochin shore of the harbour, some two miles from the entrance, is not salty to the taste, soap lathers easily in it and it is used by the villagers for cooking.

This study was made in the sixth month commencing with the end of April 1935. It was started just before the monsoon. Unfortunately no data were obtained on the salinity of the water in the different stations. The following information was kindly supplied by the Harbour Engineers to the Madras Government.

On 21st August 1922 the salinity of the water at the centre of the harbour gut, about 2½ hours after the inflow of the tide commenced, was 1·029 specific gravity reading.

ORGANIC GROWTH ON STEEL CRAFT.

At Seattle, Washington, U. S. A., there is a series of lakes connected with the sea. These lakes have been separated by locks,

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[1] Sellius, Godofredus, 'Historia naturalis teredinus, seu, Xylophagi marini...." *4to Trajecti ad Rhenum*, 1732.

[2] Atwood, W. G., and Johnson, A. A., "Marine Structures, their deterioration and preservation," *Rept. of Ctte. on Marine Piling Investigations of the Division of Engineering and Industrial Research of the National Research Council*, Washington. 1924.

[3] Redgrove, G. R., Calman, W. T. and others. *1st Report of Ctte. on the deterioration of structures of timber, metal and concrete exposed to the action of sea-water.* Inst. of Civil Engineers, London, 1920.

[4] Calman, W. T., *Brit. Mus. (Nat. Hist.), Economic Series*, 1919, No. 10.

and ocean-going freighter ships are able to free their hulls of the accumulated growth which they collect by anchoring in the eastern lake where the water is fresh, the organisms die and fall off in a few days. A similar procedure is not possible in Cochin harbour because the channels are very shallow, except where they have been dredged just inside the harbour mouth. Steel barges which carry oils to Quilon, over one hundred miles to the south, and to Kottayam about 45 miles to the south, must go into dry dock every three or four months to have barnacles and oysters removed. These animals attach themselves all over the keels from about six inches below the water line. They are able to penetrate the so-called anti-fouling paint and then start oxidation in the steel plates finally causing small corroded pits.

There are no boring organisms which attack steel.

Balanus sp., the common barnacle grows slowly in Cochin harbour and vicinity and dead cases of half-grown individuals are often present. The low salinity is probably responsible for this. Nevertheless there is always an abundant supply of young animals on immersed surfaces, and there must be strains of barnacles and oysters here which are adapted to a low salinity.

ORGANISMS BORING INTO SUBMERGED WOOD.

Most of the transportation in the backwaters is done in wooden vessels called vallams. They are usually made of Venteak or Marudu wood boards sewn together with coir (cocoanut fibre) cords. It is necessary to bring these boats into dry dock about twice a year to renew planks which have become weakened by molluscan borers.

Boards which appear sound from the outside may be riddled and honeycombed with burrows within, because the molluscan borers enter the wood as microscopic larvæ. The shipworms remain in their original burrows until death and retain the first entrance point for breathing purposes. When infected wood is immersed the two short siphons of each shipworm can be seen protruding from these small holes, which are only 1–3 mm. in diameter. As soon as the wood is not submerged the siphons are withdrawn and the entrance to the burrow is closed by a ring of tissue on the siphons and by two tiny shelly scales, the pallets. The Teredinidæ are differentiated taxonomically chiefly by the morphology of these pallets. When the wood they inhabit is withdrawn from the water the molluscs keep their burrows closed and full of salt water. Thus they are able to survive for even fourteen days.[3] Bhum[5] found that *Teredo navalis* L. was able to survive in a low lethal salinity so long that after thirty-three days 10% of the animals were still alive.

Table I shows the borers which were found in seven pieces of wood from different places around Cochin harbour in April and May 1935. Two genera of the Teredinidæ were present. Teredo with simple pallets, and Bankia (syn. *Xylotria*) with compound pallets. No large individuals of Teredo were found, and this genus is evidently more intolerant than Bankia of brackish water, although Miller[10] found the opposite to be true in California; Calman[4] states that Teredo will not flourish in brackish water. Molluscan borers belonging to the family Pholadidæ are very abundant in the Cochin waters, they were present in every wood specimen. These have been identified as *Martesia striata* L., by G. I. Crawford, Esq., London. This borer has a cosmopolitan range and is abundant everywhere in the tropics (Miller, 9, plate 8). Although Martesia were obtained three miles out to sea, they were also abundant in logs lying in only slightly brackish water in the Tatapuram boat basin (see Table I). The Pholadidæ have short bodies which are completely invested in the scabrous shells. The shells of young Martesia resemble those of young Teredo, but there are no pallets. There is a pair of small accessory plates between the valves of the shell on the dorsal surface, and also a larger ventral plate in Martesia. These borers are drop shaped and fit closely into their burrows, where they form plugs just under the surface of the wood until they die. In the adults a shelly dome continuous with the valves covers the foot and prevents further boring. The largest Martesia were $1\frac{1}{2}''$ long and about $\frac{3}{4}''$ thick near the base.

The absence of Teredinidæ in the old cocoanut-piles from the Standard Oil Company's Jetty may be attributed to the turbid shallow water there. Shipworms cannot thrive in turbid or sewage polluted water,[3] but such conditions do not deter Martesia.

[5] Bhum, H. F., *Univ. of Calif. Publ., Zoo.*, 1922, **22**, Pt. 4, p. 349.

TABLE I.

Boring organisms found in submerged wood, Cochin Harbour, April 1935.

Type of wood, location and time immersed.	Teredinidæ.	Pholadidæ.	Crustacean Isopoda and other borers.
Poon wood. Dolphins beside dry dock, Willingdon Island. 10 yrs. Copper sheathed.	*Bankia setacea*, 2 : 19″ and 21″ long, also empty burrows.	*Martesia striata*, 1 adult.	*Sphæroma terebrans* and *S. Annandalei*, very numerous.
Marudu plank. Jetty, N. E. Willingdon Isl. 2 yrs.	Burrows, 1 large, several small, empty. *Teredo diegensis* Bartsch, 1, young, ¼″ long.	None.	*Sphæroma terebrans*, very numerous, burrows to ¾″ deep. Polychæta, 1.
Teak. Edge of pile. Vypeen reclamation. 2 yrs.	None.	*Martesia* adults, heavy infection.	*Sphæroma terebrans*, several.
Teak. Channel buoy, 3 mls. out. 6 months.	,,	*Martesia striata*, several young and adults.	None.
Marudu. Plank from vallam. 6 months.	Few empty burrows 6″-10″ long.	*Martesia striata* L., heavy infection.adults.	Polychætæ, 2 large adults.
Cocoanut wood pile, Standard Oil Co. Jetty, 2½ mls. N. E. of harbour. 5 yrs.	None.	*Martesia striata*, many adults.	None.
Eriodendron log. Boat basin, Tatapuram. 2 mls. N. E. of harbour. 4 months.	,,	*Martesia striata*, heavy infection with half-grown animals.	,,

There is also a Crustacean Isopod borer which causes a great deal of damage, particularly to docks and piers in Cochin, and which belongs to the widely distributed genus Sphæroma.[4] Sphæroma is common in the tropics and in the southern hemisphere and is a relative of the smaller Limnoria or "Gribble" of northern waters. Specimens from Cochin have been identified as *S. terebrans* Bate, and as *S. annandalei* Stebbing.[6] These Crustaceans do not usually attack floating timber. Unlike Limnoria, Sphæroma can thrive in almost fresh water.[3,7] They are very destructive and often form colonies where the burrows are twelve to sixteen to the square inch. The burrows are visible from the surface, and are from ¼″ to 1″ in depth and up to 1/5″ in diameter with straight sides. Adults swim about and can leave their burrows at any time and attach themselves to a fresh piece of wood. They begin to bore in any cranny or flaw, and were often found in empty barnacle shells. At mating time a male shares a burrow with a larger female. Females were seen in August with brood pouches full of young, and they probably breed throughout the year.

[6] Stebbing, T. R. R., *Rec. Ind. Mus.*, 1911, **6**, Pt. 4, 81–182.

[7] Miller, R. C., *Ecology*, 1926, **7**, No. 3, 247–254.

TRAPS FOR MARINE BORERS.

Traps were constructed as directed by Atwood and Johnson.[2] Each consisted of seven blocks of wood, 10 × 4 × 2½ inches, attached to an upright post. These were immersed at three stations :—(1) Traps I and II off the north-east shore of Willingdon Island Reclamation in the centre of the harbour ; (2) Traps III and IV off British Cochin near the harbour entrance where the water was saltiest ; (3) Traps V and VI at the mouth of the Government Canal, two miles north-east of the harbour entrance at the Burmah Shell Company's jetty. At stations 1 and 2 two traps were set, one of hard Marudu wood and one of softer Venteak. At station 3, both traps were of Marudu, one untreated, the blocks of the

second had been soaked in an oil preservative. Growth was found to be so slow that it was unprofitable to examine the blocks more often than once in two months. The data from these examinations are shown in Table II, for Traps I to IV. After seven months, three remaining blocks from each trap were shipped to Madras, where I examined them. They had been *en route* for five days, yet all organisms were still alive.

On all traps, blocks number 4 were about half way between high and low tides, ordinary spring tides; blocks 1–5 were always exposed at low tide, and blocks 6 and 7 only at spring tides; blocks number 1 were barely covered at high tides.

An indication of the quantity and quality of the surface growth on the blocks is given in Table II, column 2. It has been observed that this growth accumulates far more rapidly in traps laid down off Madras in the Bay of Bengal than in Cochin Harbour. Professor R. Gopala Aiyar agrees that the low salinity in Cochin is probably responsible for the slow growth there.

Efficiency of Oils in Preserving Marine Structures.

Fish oil and bitumen are used locally in Cochin to protect wooden craft against marine borers. Two traps of Marudu wood blocks were set in the water at the Burmah Shell Jetty on June 1, 1935; one was of untreated wood, the blocks of the other had been soaked in a mixture of one part fish oil and one part bitumen. The water at this station is almost fresh after the monsoon, and is turbid with silt and sewage. After two months, on August 1, blocks number 4 were removed. There was a sparse surface growth of barnacles and algæ (*Chætomorpha linum* Fl. Dan.; *Caloglossa leprieuru* (Mont.) J. Ag.: *Microcoleus chthonoplastes* Thuret.*) but no borers were seen. After three months, in September, blocks number 5 were examined. The surfaces were covered in fine silt and there was scarcely any organic growth. No borers were found in the untreated block. The treated block contained several small burrows of *Martesia striata* 1/16 inch in diameter, on all surfaces, a few of which were dead. A few *Sphæroma terebrans* had also started to burrow in flaws and cracks in the wood.

* I am obliged to Prof. M. O. Parthasarathy Iyengar for these identifications.

In October, after four months immersion, blocks number 6 were examined. The untreated block contained several scattered young Martesia burrows on all surfaces. The treated block also contained Martesia, but fewer than the untreated block. A few Sphæroma had burrows to $\frac{1}{8}''$ deep in the treated wood. While dissecting the blocks it was obvious that the oil treatment had softened the wood, thus facilitating penetration.

Periodicity and Growth of Marine Borers.

1. *Sphæroma terebrans* and *S. annandalei* were always active. They attacked blocks from 8″ below to $2\frac{1}{2}'$ above low water ordinary spring tides.

2. *Martesia striata* larvæ were present from April to October. They attacked blocks from 6″ to 2′ above low water ordinary spring tides. They attacked softer wood more readily than harder, but not until the blocks had been immersed over two months.

3. *Teredo* spp. larvæ were present from May to September. They attacked blocks 1″ below and 9″ above low water ordinary spring tides. They also attack softer wood first and grow twice as fast in Venteak as in Marudu. No infections were found until wood had been immersed for more than two months. Growth was very slow, burrows were only four inches long in Venteak after five months immersion. Miller[8] reports a similar growth rate for Bankia in California, but much faster rate of growth has been reported by others for the coasts of North America and elsewhere.[4,9] Again the low salinity after the monsoon is no doubt responsible. A variety of pallets of Teredo were found, and these have been tentatively identified according to the key of Hill and Kofoid[11] and Miller's figures[10] as belonging to four species; *T. diegens is* Bartsch, *T. furcillatus* Miller, *T. navalis* L.

[8] Miller, R. C., *Uni. of Wash. Publ., in Oceanography*, 1935, **2**, No. I, pp. 1–18.

[9] White, F. D., *Contrib. to Canadian, Biol. and Fisheries, N. S.*, 1929, **4**, 1–25.

[10] Miller, R. C., *Univ. of Calif. Publ. in Zoo.*, 1924, **26**, No 7, 145–158.

[11] Hill, C. L. and Kofoid, C. A., *Final Report of San Francisco Bay Marine Piling Cttee.*, Univ. Calif. Press, 1927 (Key to *Teredinidæ* by Bartsch).

TABLE II.

Growth found periodically in wood blocks of traps set in Cochin Harbour.

TRAP I. VENTEAK, AT EXECUTIVE ENGINEER'S JETTY, NORTH-EAST END OF WILLINGDON ISLAND. IMMERSED 24TH APRIL 1935.

Block examined, date and time immersed.	Surface growth.	Borers present.
*4, 22nd May. 1 month (renewed)	Barnacles—sparse. Green alga, *Chætomorpha*. Crustacean larvæ.	None found.
*4, 20th July. 2 months (renewed).	Alga—*Rhizoctonia*, sparse. Thick growth of small barnacles, and Diatoms. Crustacea and Polychætæ.	,,
*5, 20th July. 3 months.	Barnacles less than *4. Algæ: *Rhizoctonia* and *Caloglossa*. Larvæ.	*Martesia* on top, scattered holes to ¼″ diameter, some dead. Larvæ of boring molluscs. *Sphæroma*, few in empty barnacle cases, no burrows.
*4, 6th September. 7 weeks.	Barnacles over 50% of surface. Mat of green algæ, diatoms, sponges. Protista, Molluscan larvæ, nemas and crustacean larvæ.	*Sphæroma*—1 colony in crack in wood, also Polychæte worm.
*3, 6th September. 4½ months.	Barnacles, heavy incrustation. Green algæ and small sponges, diatoms, etc. as *4.	*Sphæroma*, few half-grown animals in burrows on the base of block.
*6, 24th September. 5 months.	Barnacles scattered all over to ½″ diameter, some empty. Green algæ, sparse, *Chætomorpha*; some blue green *Microcoleus*. Protista, sponges, Crustacean larvæ and young.	*Sphæroma*, numerous scattered burrows to ¼″ deep, in face ends and top of block. *Martesia*, few in face, ⅛–½″ high. *Teredo*, numerous burrows in top and front in ¾″ saturated wood. Pallets variable. *T. diegensis* and *T. navalis*. Burrows 2–4″ long.
*1, 2 and 7, 30th November. 7 months.	Barnacles over all surfaces, some *Mitellus*, and Alga—*Chætomorpha*.	*Sphæroma*, few small burrows in each block.

TRAP II. MARUDU WOOD. WITH TRAP I. IMMERSED 24TH APRIL 1935.

*4, 22nd May. 1 month (renewed).	As Trap I.	None found. Larva of boring Mollusc.
*4, 20th July. 2 months (renewed).	,,	None found.
*5, 20th July. 3 months.	,,	*Sphæroma*, few in empty barnacles. *Martesia*, few holes to ¼″ diameter, all dead, orifices 1′16″. Less infection than in Venteak.
*4, 6th September. 7 weeks.	,,	None found.
*3, 6th September. 4½ months.	,,	,,
*6, 24th September. 5 months.	,,	*Sphæroma*, *Martesia* and *Teredo*, all less than in Trap I. *Teredo* ½–1″ long, several dead. Few *Martesia* ¼″ high, mostly dead.
*1, 2 and 7, 30th November. 7 months.	,,	*Sphæroma*, few burrows in Bl. 2, no borers in *1 and 7.

TRAP III. VENTEAK, AT PORT TRUST JETTY, NEAR HARBOUR ENTRANCE, COCHIN. IMMERSED 26TH APRIL 1935.

Block examined, date, and time immersed.	Surface growth.	Borers present.
*4, 22nd May. 1 month (renewed).	Barnacles, small, covering whole surface. Also many colonial hydroids, diatoms, nemas, protista, crustacean larvæ.	*Sphæroma*—2 small ones in empty barnacle case.
*4, 27th July. 2 months (renewed).	Barnacles covering whole surface; green algæ *Chætomorpha*, diatoms and crustacean larvæ.	None found.
*5, 27th July. 3 months.	Thick surface coating of barnacles, *Mitellus*, sponges, larval cases, few green algæ, with Crustacea and Planaria.	*Teredo*, several small burrows ¼–½″ long in base. *T. furcillatus* Miller, *T. navalis* L. and *T. samœnsis* Miller.
*4, 6th September. 6 weeks.	Covered in silt, very little growth. Few barnacles and green algæ, *Chætomorpha*.	*Sphæroma*, 3 small, in crack in block.
*3, 6th September. 4½ months.	Heavy growth of Barnacles and *Mitellus*; green and red algæ and silt. Crustacea and worms.	*Sphæroma*, 6 small, starting to burrow underneath. *Martesia*, 3 tiny specimens, burrows 1/16″ long. 1 dead.
*6, 25th September. 5 months.	Heavy, thick encrustation as *3, 6th September.	*Sphæroma*, few small in burrows.
*1, 2 and 7, 30th November. 7 months.	Barnacles over whole surface. Some algæ, *Chætomorpha* and *Caloglossa*.	*Sphæroma*, few burrows in 1/5″ deep in each block.
TRAP IV. MARUDU WOOD. WITH TRAP III. IMMERSED 26TH APRIL 1935.		
*4, 22nd May. 1 month (renewed).	As Trap III.	None found.
*4, 27th July. 2 months. (renewed).	,,	,,
*5, 27th July. 3 months.	,,	*Teredo*—few short burrows at ends ¼–½″ long. *T. navalis* L. *Sphæroma*, 1, in short burrow.
*4, 6th September. 6 weeks.	,,	None found.
*3, 6th September. 4½ months.	,,	*Sphæroma*, 5, in short burrows.
*6, 25th September. 5 months.	,,	None found.
*1, 2 and 7. 30th November. 7 months.	,,	*Sphæroma*, few burrows in Bl. 7, none in *1 and 2.

and *T. samœnsis* Miller. Professor R. C. Miller and other specialists have informed me that the taxonomy of this genus is still in a state of flux.

(4) *Bankia setacea* was not found in the traps. White[9] found specimens ½″ long with typical pallets in wood after less than two months immersion in Departure Bay, British Columbia. He reports that in less than three months blocks of Douglas fir were so riddled with shipworms, that they could be broken by hand.

PROTECTION OF MARINE STRUCTURES AND WOODEN CRAFT.

Contrary to local opinion the activity of molluscan borers in Cochin harbour and vicinity is less than elsewhere. Wooden craft could certainly be protected indefinitely if they were taken into dry dock every two to three months, when the borers are tiny and close to the surface, and the keels scrubbed with a cheap poisonous wash, such as copper sulphate, mercuric bichloride, hot brine or lye solutions.

Fish oil and bitumen do not act as deterrents. They soften hard wood and seem to be attractive to Martesia.

Silt, sewage and a heavy incrustation with barnacles all tend to prevent the entrance of molluscan borers.

Sphæroma are always numerous and there seems to be not a way of protecting wooden piling except by sheathing them in copper or concrete.

SUMMARY.

Wood block traps were immersed at three stations in and near Cochin Harbour. They showed that the waters contain active larvæ of Martesia and Teredo from April to October. Owing to the low salinity growth of Teredo is very slow.

There are strains of Martesia and Balanus which can grow in almost fresh water.

According to pallet morphology four species of Teredo were found. Their attacks are limited to the region near the harbour mouth where the water is salt, and at levels at and near low water line.

Bankia setacea adults 19″ and 21″ long were found in wooden piles in the harbour, but no young appeared in the traps.

Sphæroma are always abundant and very destructive to piling.

Records of growth found in the traps for bi-monthly periods between April and November 1935 are given, also suggestions for the protection of wooden craft.

Centenaries in April 1936.

Grover (John William), 1836-1892.

JOHN WILLIAM GROVER, born on 20th April 1836, was an engineer with wide practice in several countries. He had his education first at Marlborough College and later in Germany. He was apprenticed under Sir Charles Fox and Sir John Fowler. His field of interest shifted from time to time. In the earlier years, he was engaged in Museum architecture and was associated with the building of the north and south courts of the South Kensington Museum and the erection of the conservatory of the Royal Horticultural Society. He also took a prominent part in the erection of buildings for the Exhibition of 1862. He was also associated with the erection of the Royal Albert Hall.

AS A RAILWAY ENGINEER.

In his 26th year, he set up independent practice as a Railway Engineer. His first work was the construction of 27 miles of the Manchester and Milford Railway. He surveyed various railways in Europe and prepared designs for the works of the Mexican Railway. The Kingland iron bridge, of 200 feet span over the Severn built by him, is said to present some novel features of construction. In 1873, he constructed the Mountain Railway of Venezuela. While at Venezuela he made a hydrographical survey of the coast of that country and thus prepared the way for the construction of the harbour of La Guaira.

AS A WATER-WORKS ENGINEER.

From his 37th year, he turned his attention to water-supply. He designed and constructed the water works of several towns in the Chalk districts. He was an authority on the water-supply of London. He was also employed in the survey of water-supply in Austria, Denmark, Egypt, Italy and Switzerland.

He was elected a member of the Institute of Civil Engineers in 1867 and was also a Fellow of the Society of Antiquaries and a Vice-President of the British Archæological Association.

Mr. Grover died at his residence in Clapham Common, on 23rd August, 1892.

HIS PATENTS AND PAPERS.

Of the patents taken out by Grover, the most widely known is the one for the "spring washer", used to prevent the slacking of permanent way fish bolts. These washers are being used in all parts of the world.

His chief papers are the following:—

1. "Estimates and Diagrams of Railway Bridges," 1866. 2nd edition in 1870. 2. "The Facilities of 'flexible' Rolling-Stock for economically constructing... Railways or Tramways," 1870. 3. "Description of a Wrought-iron Pier," 1871. 4. "Iron and Timber Railway Superstructures," 1874. 5. "Suez Canals from

the most ancient times to the present," 1877. 6. "Section of a well at Hampstead," 1878. 7. "Ancient Reclamations in the English Fenlands," 1878. 8. "Chalk water-springs in the London Basin," 1887. 9. "Proposed Richmond Footbridge," 1890. 10. "An explanation of the London Water Question," 1892.

S. R. RANGANATHAN.

Tschermak (J. L. Gustav), 1836-1927.

THIS veteran mineralogist of Czechoslovakia was born on 19th April 1836. His father was a tax collector. As a school boy, he was marked by his independence and enterprise and he was the founder of a natural history society. In 1856, he went to the University of Vienna and later to Tubingen, where he graduated in 1860. He was the Director of the Hofmineralien Kabinet in Vienna from 1868 to 1877. From 1868 to 1906 he was Professor of Mineralogy and Petrography in the University of Vienna. Professor E. S. Dana of America was one of his distinguished students in 1873–74.

HIS WRITINGS.

Tschermak was a prolific writer. He has to his credit no less than 153 papers, of which only 5 were joint papers. His first paper appeared as early as 1858, in his 22nd year, in *Wien. Geol. Verhandl.* It was entitled *Trachytgebirge bei Banow.* His last paper was *Der Chemische Bestand und das Verhalten der Zeolithe.* It appeared in 1918, in his 82nd year, in the *Sitzb. Akad. Wiss., Wien.* His *Grundriss der Mineralogie* came out in 1863, while the first edition of his well known *Lehrbuch der Mineralogie* appeared in parts during 1881–1884. This book reached its ninth edition in 1923.

HIS CHIEF CONTRIBUTIONS.

While his earlier papers were of a petrographical nature, he will be remembered longest for his classic memoirs on the chemical constitution of various groups of silicate minerals. These include *Felspars* (1865), *Amphibolers* (1871), *Micas* (1877), *Zoisite-epidotes* (1880), *Scapolites* (1884), *Chlorites* (1890), *Vermiculites* (1891), *Tourmaline* (1899), and *Zeolites* (1918).

FOUNDS A PERIODICAL.

He is also well known through the important periodical he founded which, as *Meneralogische Mitteilungen*, was first issued from 1872 to 1877, in quarto form as a supplement to the *Jahrbuch der K. K. geolischen Reichsenstalt, Wien.* It took an octavo form in 1878 and continued to appear in that form till 1889, under the title *Mineralogische und Petrographische Mitteilungen.* In 1889, the editorship went over to F. Becke, who changed its title to *Tschermak's Mineralogische und Petrographische Mitteilungen.* Yet another change came over this periodical in 1930 when it was taken over by the Akademische Verlaggesellschaft in Leipzig and was made Abteilung B of the *Zeitschrift für Kristallographie Mineralogie und Petrographie.*

HONOURS.

He was elected Foreign Correspondent of the Geological Society of London in 1875. He was made a Foreign Member in 1886. He was elected an Honorary Member of the Mineralogical Society of London in 1879. In 1875, he was made a Full Member of the Kais. Akademie der Wissenschaften in Wien. He was Rector of the University of Wien in 1893. He was one of the founders and the first President of the Wiener Mineralogische Gesellschaft (1901). He was also Honorary Member of the Academies at Berlin, Göttingen, Munich, Paris, Rome, Leningrad and Sweden. He was raised to peerage in 1906 with the hereditary title Edler von Seysenigg. In 1873, F. von Kobell perpetuated his name by naming a mineral as 'tschermakite.'

PERSONALITY.

Professor Dana describes him as a charming courtly gentleman. He was most kind and helpful to the younger aspirants. His popularity among all those that came into personal contact with him is demonstrated by an extraordinary gesture of regard which he experienced since 1920. The War left him in straitened circumstances. But his life was made comfortable by substantial monthly remittances from the American mineralogists who were his admirers. Although he lived to 91 years, he retained his clearness of mind almost to the day of his death—May 4, 1927.

S. R. RANGANATHAN.

Letters to the Editor.

CONTENTS.

Oxygen in Solar Prominences.

IN *Kodaikanal Observatory Bulletin* No. 107 the existence of oxygen in the solar chromosphere was demonstrated by spectrograms taken in full sunlight. The dismantling of the spectrograph for use at the solar eclipse of June 19th, 1936 makes it opportune to report progress on the results of observations of the oxygen lines in solar prominences. The lines used were the infra-red triplet at λ 7770.

When a solar prominence is on the slit of the spectrograph, the oxygen triplet is found to be present, although always very faint. The conditions for photographing the oxygen triplet in a prominence are more easily attained than those for photographing it in the chromosphere since there is less difficulty with the tremor of the sun's limb, but the demonstration of the oxygen triplet reversals in a prominence is less frequently successful on account of the faintness of these lines in prominences compared with the sky spectrum. It is necessary to have a bright prominence and a blue sky to show the oxygen triplet brightly reversed against the sky spectrum.

The best results so far were obtained in a narrow prominence on the 11th December, 1935. The lines of the oxygen triplet were found in this prominence at a height of about 20″ above the chromosphere, or 9,000 miles. There was no possibility of these lines being due to chromospheric light, as the reversals were short in length corresponding to the short length of the prominence on the slit.

The photometry of these faint lines in full sunlight will always be a matter of difficulty on account of the presence of the sky spectrum and it seems best to wait until eclipse photographs are available for oxygen lines.

Kodaikanal Observatory, *March* 20, 1936. A. L. NARAYAN. T. ROYDS.

Absorption Spectra of Halides and Oxyhalides of S, Se, and Te.

IN continuation of earlier work on the chlorides and oxychlorides of sulphur,[1] we have measured the absorption spectra of a number of halides and oxyhalides of S, Se, and Te in the vapour state. The observed maxima of selective absorption together with their long wave limits are listed in Table I and we have added also the bond energies (in K. cal/mol) corresponding to the correlated

TABLE I.

	I Absorption				II Absorption				III Absorption				IV Absorption			
	Red wave lim.		Maximum		Red wave lim.		Maximum		Red wave lim.		Maximum		Red wave lim.		Maximum	
	λ (mμ)	Kcal/mol	λ (mμ)	Volts.	λ (mμ)	Kcal/mol	λ (mμ)	Volts	λ (mμ)	Kcal/mol	λ (mμ)	Volts	λ (mμ)	Kcal/mol	λ (mμ)	Volts
$SOBr_2$					378	75	327	3·7	281	101	265	4·6	245	116		
					$2\,D_B\,(S-Br) = 74$				$2\,D_B\,(S-Br^*) = 95$				$D\,(S=0) = 116$			
$SeCl_4$	(415)	(68)	325	3·8					301	94	275	4·5	(250)	(114)	(240)	(5·1)
$SeOCl_2$									315	90	266	4·6	250	114		
Se_2Cl_2					410	69	350	3·5	320	89	295	4·2	249	114	(237)	(5·2)
	$D_B\,(Se-Cl) = 47$				$D\,(Se_2) = 59$				$2D_B\,(Se-Cl) = 94$							
$SeBr_4$	580	47	490	2·5	530	55	427	2·9	350	81	262	4·7	250	114		
Se_2Br_2					465	61	384	3·2	350	81	322	3·8	288	98	257	4·8
	$D_B\,(Se-Br) \sim 42$				$D_B\,(Se-Br^*) \sim 53$ $D\,(Se_2) = 59$				$2\,D_B\,(Se-Br) \sim 84$				$2\,D_B\,(Se-Br^*) \sim 106$ $D\,(Se=Se^*) = 87$			
$TeCl_2$	480	59	317	3·9					290	98	251	4·9	246	115		
$TeCl_4$	480	59	324	3·8					272	105	247	5·0				
	$D_B\,(Te-Cl) = 55$								$2\,D_B\,(Te-Cl) = 110$							
$TeBr_2$	535	53	473	2·6	420	67	380	3·2	340	84	314	3·9	293	97	(228)	5·4
$TeBr_4$	525	54	465	2·7			(400?)		296	96	265	4·6	(249)	(114)		
	$D_B\,(Te-Br) = 48$				$D_B\,(Te-Br^*) = 59$				$2\,D_B\,(Te-Br) = 96$				$2\,D_B\,(Te^*-Br) = 124$ $2\,D_B\,(Te-Br^*) = 108$			

processes of photo-dissociation. D_s denotes values calculated from thermo-chemical data, *e.g.*, D_s (Te – Cl) is one quarter of the heat of formation of $TeCl_4$ from the gaseous atoms (not from the elements), D denotes a value taken directly from the band spectra of the diatomic molecules. Wherever a dissociation involves excited products, this is marked by an asterisk against the atom undergoing excitation. Some of the thermo-chemical data, particularly the latent heats of the compounds, are uncertain, and, as discussed elsewhere, it is difficult to determine that value of the long wave limit, which belongs to the molecule in its lowest state of vibration. Considering this, the agreement is very satisfactory.

Similar to the spectrum of S Cl_2, the di= and tetrahalides possess different regions of selective absorption in which at first one and then a second halogen atom is split off. From those molecules containing a double bond, *e.g.*, the mono = and oxyhalides, always two halogen atoms are split off simultaneously. The breaking up of the double bond is observed where its energy value comes in the region under observation and the same holds for the dissociation of excited atoms, which can be observed for instance in the second and fourth region of selective absorption of the di = and tetra bromides, the electronic separation of the chlorine atom (881 $cm.^{-1}$), being too small to be resolved in the spectrum.

These results confirm entirely the conclusions, drawn from the corresponding photo dissociations of the chlorides and oxychlorides of sulphur and of other molecules. Furthermore, since the process of photo-dissociation determines the energy value of an individual bond directly, and not as part of a grand total as in thermo-chemical experiment, it can be seen that the bond energies are approximately additive in the same molecule and remain approximately constant in all the di = and tetravalent molecules. This result can hardly be understood otherwise than in a pair bond theory of valency, in which each linkage is produced by a pair of electrons, one from each atom, and localised between them.

A detailed report will be published elsewhere.

S. L. HUSSAIN.
R. SAMUEL.

Department of Physics,
Muslim University,
Aligarh,
April 5, 1936.

[1] R. K. Asundi and R. Samuel, *Proc. Phys. Soc.* (London), **48**, 28, 1936; Mohd. Jan Khan and R. Samuel, *Ibid.*, in Press.

Note on the Raman Spectra of Metallic Formates and the Constitution of Formic Acid.

IN a recent paper[1] I have shown that the formates of sodium, calcium, cadmium and lead yield Raman lines both in the state of solid and aqueous solutions, the average frequencies of which are 2834, 2732, 1717, 1534, 1347 and 851 $cm.^{-1}$ Besides, in the solids two other frequencies are also present at 2976 and 1397. The frequency shifts in the sodium formate solution have since been confirmed by Edsall.[2] Of these frequencies 2834 was assigned by me to the valence oscillation and 1347 to the deformation oscillation of the HCO group in the formate ion. The origin of the line at 1534 which is of medium intensity in the lead formate crystals was then considered to be uncertain.

In view of the doubt expressed by Halasyam[3] regarding the assignment of 2834 and 1347, I may indicate the following points in support of my conclusion as to the existence of the aldehyde group in the formic acid.

1. In general, the Raman frequencies between 2600–3400 in the organic substances have their origin in the valence oscillations of the X—H bindings.[3] In the case of the formate ion (HCO_2^-), only two forms of X--H are possible, namely, CH (aldehyde group) or OH (Ray-Sarkar[5]). The OH frequency is always higher than 3300 and hence the only possible bond to which 2834 could be ascribed is the CH.

2. The absence of any line at about 3300 even in the fairly intense spectrum of lead formate crystals indicates the non-existence of any OH group in the ion.

3. In the crystals of lead and calcium formates a weak line was present at 2973 which coincides with the CH frequency in the formic acid.

4. In their detailed study of 16 aliphatic aldehydes R.CO.H (with R=H to R=C_9H_{19}) Kohlrausch and Köppl[6] observe "ω=1379 in H.CO.OR and ω = 1390 in H.CO.R sind vermutlich die CH Deformationsfrequenzen des endständigen Wasserstoffatoms; an der Stelle 1390 weisen dementsprechend auch Formamid (H.CO.NH^2) und Ameisensaure (H.CO.OH) kräftige Linen auf." The corresponding line in all the formates appears

at about 1347 and is the most prominent line in their spectra. It is interesting to note that the ratio of this frequency of the formates to the line 2834 representing the valence oscillation is practically the same as the ratio between the corresponding lines in the formic acid or other aldehydes.

The large shift from 2963 in the formic acid to 2834 in the aqueous solutions of the formates is evidently to be attributed to the influence of the field of the neighbouring ions on the CH group, *tending to diminish the binding force between the carbon and the hydrogen atoms.* This does not mean complete rupture of the CH bond as is apparently supposed by Halasyam (*loc. cit.*). The CH frequency is known to be very sensitive to the influence of the surroundings.[7] It has as low a value as 2867 in chloral ($H.CO.CCl_3$) or 2882 in formamid ($HCO.NH_2$) which are not far from 2834 observed by me in the formate ion. A comparison of similar influences on the CH frequency in acetates, propionates, etc., with those of formates is not justifiable; because in the former there are other CH_2 groups present whose vibrations are not affected in the same manner as those of the CH attached directly to the ion as in $\left[H.C\begin{matrix}O\\O\end{matrix}\right]^-$ and which give rise to the line in the unshifted position. It may, however, be pointed out that even in the case of the acetates a similar lowering of the frequency could be inferred from the results of Edsall (*loc. cit.*) who has reported a weak line at 2851 in sodium acetate while there is no line below 2936 in the 33% aqueous solution of acetic acid.

These facts point definitely to the conclusion that *the Raman spectra data of formates indicate the presence of the aldehyde group in the formic acid and do not support the alternative constitution proposed by Ray.*[5]

If we neglect for a moment, H in the ion $\left[H.C\begin{matrix}O\\O\end{matrix}\right]^-$ the line at 1534 as well as the two other lines 1717 and 857 in the formates could be explained as due to the vibrations of the configuration $C\begin{matrix}O\\O\end{matrix}$ considered as a non-linear molecule of the XYZ type. For such a molecule three distinct modes of vibration are possible and the line 1534 which is more intense than the other two may correspond to the vibration with the maximum possible symmetry.

C. S. VENKATESWARAN.

Physics Department,
Indian Institute of Science,
April 4, 1936.

[1] Venkateswaran, C. S., *Proc. Ind. Acad. Sci.*, (A), 1935, **2**, 615.
[2] Edsall, J. T., *Jour. Chem. Phy.*, 1936, **4**, 1.
[3] Halasyam, R. M., *Curr. Sci.*, 1936, **6**, 651.
[4] Kohlrausch, *Der Smekal-Raman Effect*, 1931, 151.
[5] Ray, P. C., *Nature*, 1934, **133**, 646.
[6] Kohlrausch and Köppl, *Z.f. Phys. Chem.*, 1934, **24**, 370.
[7] Kohlrausch, *Der Smekal-Raman Effect*, 1931, 160.

A New Groundnut *Arachis hypogæa*, Linn. Var. *Gigantea* Patel et Narayana (*Var. Nova*).

Derivavit ab A. H. 32 × A. H. 17; generatio vera.

Typicus: ad Agricultural Research Station, Tindivanam.

Properitas ex *Arachis hypogæa*, exceptio:

(i) Rami 5′ longi, et humiles.

(ii) Flores in spicum, bracteatæ, laxum; axis ex inflorescentia 4″–8″, elongatus.

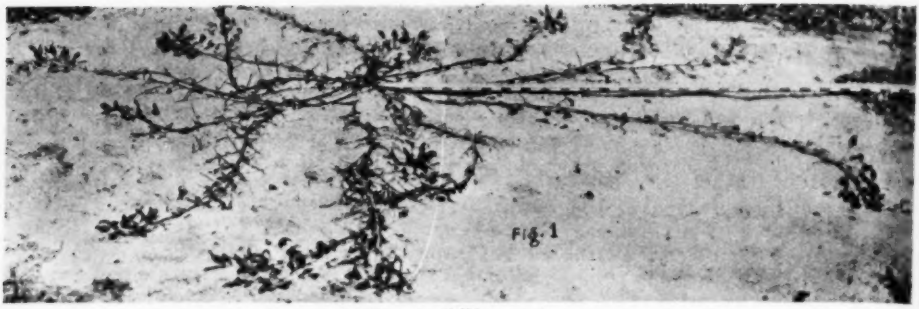
Two types of habit are commonly recognised in groundnut, *viz.*, the bunch and the spreading. The habit of growth of the bunch type is characterised by the primary branches rising obliquely from the base of the main axis, while in the spreading the primaries are procumbent.

From the progenies of a cross between a bunch variety, *viz.*, A. H. 32 Gudiyattam bunch and a spreading variety A. H. 17 Madagascar a strikingly new, hitherto undescribed variety (Fig. 1) has been isolated; and this has been breeding true.

The chief distinguishing feature of this variety is the extraordinary length of the primary and secondary branches which are robust and grow up to an average length of 5′ and radiate on all sides and are entirely prostrate or trailing throughout their length. The main axis which is erect at first, attains, unlike their parents, a height of about 2′ and assumes a procumbent habit as the plant advances in age and produces numerous gynophores or pegs even from the nodes higher up the main axis.

In none of the varieties or the species of groundnut such extraordinary long branches are met with.

Another striking character which distinguishes the plant from other varieties or progenies of other crosses is its inflorescence.



Entire plant 1/10 natural.

In parents, as a matter of that, in any other groundnut variety or species including *Arachis Rosteiro* and *Arachis nambyquaræ*, Hoehne, the inflorescence is an axillary cluster of flowers on a congested axis (Fig. 3) rarely elongating on maturity to about $\frac{1}{2}''$ or so. This short axis is normally hidden inside the stipular sheath. But in this new variety the rachis (Fig. 2) is considerably elongated and grows out as the flowers open and attain a length of about 4″ to 8″ with distinct nodes and corresponding bracts. The nodes may have gynophores or pegs which develop normal pods.

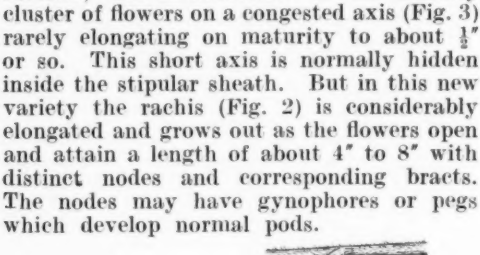


Fig. 2.
Inflorescence of the new variety (natural size).

The base of the main axis is very thick and rather woody. Other morphological characters are similar to those of the ordinary groundnut plant, though the leaves, stem and flowers, etc., are proportionately bigger than those of the male and the female parents.

According to *Linnæus*, the dense axillary and sessile spikes form the characteristic of the inflorescence of the genus *Arachis*; but the spikes of the new variety are lax, elongated as mentioned above and are sufficiently distinguishing to form at least a new species. Since it crosses rather freely with the other varieties of *Arachis hypogæa*, it has been given the status of only a variety and not a species.

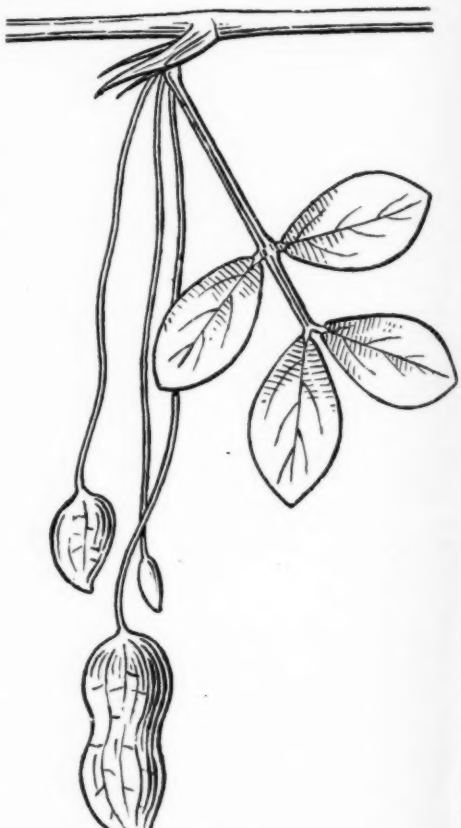


Fig. 3.
Inflorescence of *Arachis hypogæa* (natural size). *Digera Arvensis*.

C. M. JOHN.
Oil Seeds Section, C. R. SESHADRI.
Agricultural Research Institute,
Coimbatore,
February 27, 1936.

Chromosome Numbers in *Dolichos lablab* (Linn.) and (Roxb.).

THE chromosome numbers in *lablab* have been recorded by Karpechenko (1924)[1] as 22 and by N. S. Rau (1929)[2] as 24 in the somatic cells. Kawakami (1930)[3] reports 11 as the haploid number. The present investigation was done to reconcile these varying records.

Advantage was taken of the wide collection of *lablab*, both field and garden varieties to pick typical varying material for examination. Types of plant pigmentation, seed colour, pod shape and consistency from both field and garden varieties were examined. To this material was added the examination of F_1 plants from crosses between garden and field varieties. Altogether material from nine sources were taken. Flower buds about 2 mm. long were fixed between 9 and 10 A.M. after removing the calyx. Root-tips from seeds sown in saw dust were collected every hour from 6 A.M. to 6 P.M. and those collected between 6 A.M. and 7 A.M. gave the best plates for counting.

The metaphase plates in pollen mother cells showed 12 bivalents. The plates from root-tips gave 24 chromosomes. In the F_1 material no irregularity in chromosome separation was noticed. It will thus be seen that the chromosome numbers in *Dolichos lablab* (Linn.) and (Roxb.) are $2n$=24.

Nemec (1910)[4] records the $2n$ chromosome number in *D. multiflorus* as 24. N. S. Rau (1929)[2] finds 12 as the haploid number for *D. biflorus* (Linn.). The numbers observed for *D. lablab* are thus the same as those recorded for the two others, *Dolichos biflorus* (Linn.) and *Dolichos multiflorus*.

G. N. RANGASWAMI AYYANGAR.
N. KRISHNASWAMY.

Millets Breeding Station,
Coimbatore,
March 5, 1936.

[1] *Bull. Appl. Bot. Plant Breeding*, 1924–25, **14**, 143. (Abstract in *Bot. Abs.*, 1926, **15**, entry 4919, 728.)

[2] *Jour. Ind. Bot. Soc.*, 1929, **8**, 201.

[3] *Bot. Mag., Tokyo*, 1930, **44**, 319–28 (from Gaiser, *Bib. Genet.*, 1933, **10**).

[4] From Gaiser, *Bibl. Genet.*, 1930, **6**.

Double Awned Spikelets in Rice.

DURING the rice season of 1935–36 a single plant culture in the F_3 generation of a cross between the Karjat wild rice and a Burmese type was noted with some of the plants showing double awned spikelets confined to the upper part of the panicle branch (see photograph). In such plants not all the spikelets were double awned. There was variation in the number of double awned

spikelets in different panicles of the same plant.

The progeny consisted of 29 plants with some double awned spikelets and 10 plants with normal one-awned spikelets. No such condition was observed in the F_2. All the double awned spikelets were sterile. The material will be grown through further generations to see whether the condition is hereditary and fuller details will be reported in due course.

B. S. KADAM.
G. G. PATIL.
V. K. PATANKAR.

Rice Breeding Station,
Karjat, Kolaba,
February 28, 1936.

Chromosome Numbers in Cymbopogon Species.

THE Genus Cymbopogon (Gramineæ) is of considerable economic importance, in that it contains a number of species, which yield essential oils known in trade, as Lemon grass oil, Citronella oil, etc. But except the taxonomy of the various species, practically very little is known about their cytology. A study bearing on this subject has been undertaken by the author in the Oil Seeds Section of the Agricultural Research Institute, Coimbatore, with the South Indian material. Fischer (1934), in the *Flora of the Presidency of Madras*, Part X, mentions nine species occurring in South India. Five species have so far been worked out and

the chromosome numbers have been determined, as mentioned below.

Name of plant.	(2*n*) No.	(*n*) No.
Cymbopogon polyneurus	..	10
,, *cæsius*	20 ?	10+I
,, *flexuósus*	40	20
,, *coloratus*	40	..
,, *citratus*	40	..

The remaining species are being investigated.

My thanks are due to Dr. J. S. Patel, the Oil Seeds Specialist, who has suggested this investigation and who has given me the necessary facilities for work and his valuable guidance.

C. N. BABU.

Oil Seeds Section,
Agricultural Research
Institute, Coimbatore,
February 3, 1936.

Internal Proliferation in *Carica papaya* Linn.

Carica papaya is very variable under cultivation. The object of the present note is to describe a peculiar teratological phenomenon in *Carica* known as "internal" proliferation. Several small fruits found within big fruits of *Carica papaya* were sent to the authors, after the parent fruits were either eaten or destroyed. Figs. 1 and 2 show the small fruits varying in shape from oblong to napi-form. Fig. 3 shows a longitudinal and two transverse sections of the young fruit pictured in Fig. 1.

These fruits, as we are informed, were borne at the base of the parent fruits. Sections show that there is only one loculus in each and the seeds are in the normal position, that is, parietal. The fruits pictured in Fig. 2 show no seeds in them, but the whole morphological structure goes to show that they are also carpellary bodies, although further work must be done to confirm this statement.

So far as we are aware of, such a case has not been recorded in *Carica papaya*, although the abnormalities of the leaves are on record. Worsdell has mentioned under the heading of "Adventitious Flowers," a case of adventitious grapes which he has figured from Masters. This is a similar case, and it is preferred to call it "internal" proliferation rather than class it under "adventitious

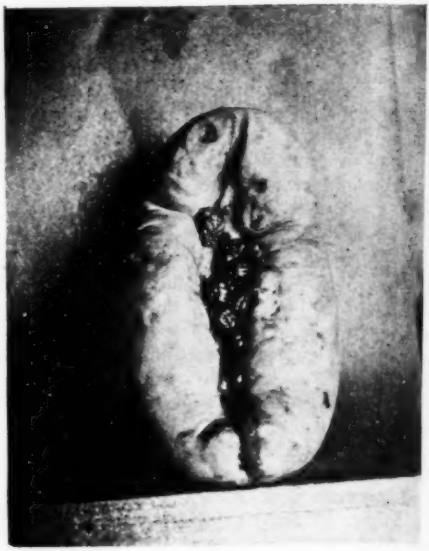


Fig. 1.

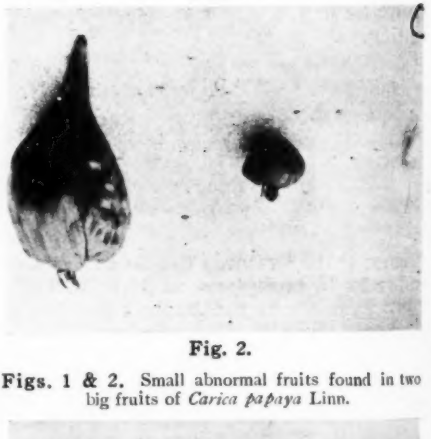


Fig. 2.

Figs. 1 & 2. Small abnormal fruits found in two big fruits of *Carica papaya* Linn.

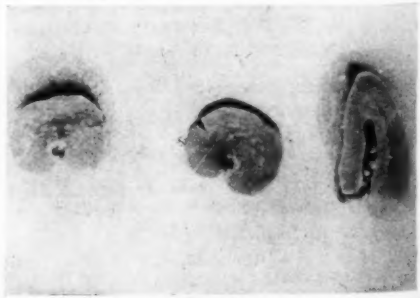


Fig. 3.

I. S. & T. S. through the fruit pictured in Fig. 1.

flowers". Recently Bausor has described a "Monstrous Fruit of Capsicum" which exhibits central or "internal" proliferation, exactly similar to our present case. In the case of Fig. 1, there can hardly be any doubt that it is a true pistil, but in the case of Fig. 2 the "fruits" are solid structures with no seeds in them. Hence it is doubted that they are not true pistils in the strict sense of the term. Perhaps they are solid carpels, as Bausor says.

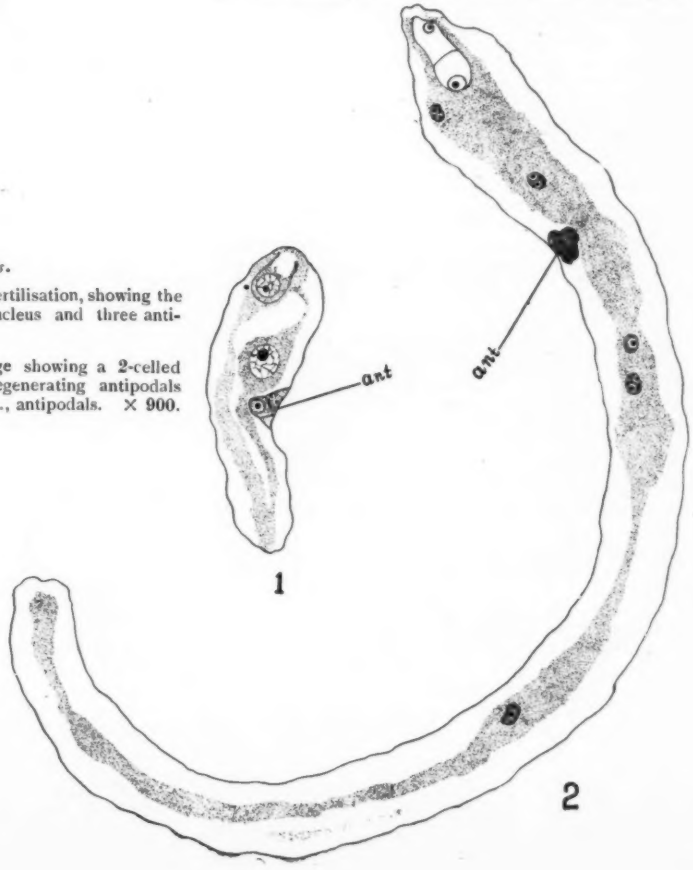
More detailed investigation is in progress, and it is hoped to throw more light on this problem shortly.

M. SAYEEDUDDIN.
A. BARI.

Botany Department,
Osmania University,
Hyderabad,
April 5, 1936.

A Note on the Antipodals of *Digera arvensis* Forsk.

ALTHOUGH the embryo-sac of *Digera arvensis* has been studied recently by Naithani,[1] Joshi and Rao[2] and Puri and Singh,[3] the behaviour of the antipodals does not seem to have been rightly followed so far. Both Naithani and Joshi and Rao have described the antipodals in *Digera* to degenerate early. A recent study of the embryo-sac undertaken in connection with the development of the embryo in this species shows that these observations are not true. It appears that generally the antipodals persist even after fertilisation. During the secondary elongation of the embryo-sac, which starts with fertilisation, the chalazal end of the embryo-sac grows along one side of them and they are left behind on one side of the embryo-sac (Fig. 1), just as Kajale[4]



Digera arvensis.

FIG. 1.—An embryo-sac just after fertilisation, showing the oospore primary endosperm nucleus and three antipodals on one side.

FIG. 2.—The same at a later stage showing a 2-celled proembryo, endosperm and degenerating antipodals in their original position. *ant.*, antipodals. × 900.

in a previous communication from this department has found to be the condition in *Alternanthera sessilis*. Some examples from other families of the flowering plants in which a similar situation has been found are mentioned in Kajale's paper. Recently Mr. C. V. Rao of P. R. College, Cocanada, in a letter to me reports the same condition in a species of *Iresine*, another genus of the *Amaranthaceæ*. This behaviour of the antipodals is therefore quite likely to be characteristic of the family.

The antipodals in *Digera arvensis* remain in this position on one side of the embryo-sac until the early stages of embryo-development, up to the 2-celled stage or so, though they begin to degenerate by this time. The embryo-sac by this time has reached a considerable length (Fig. 2).

A. C. JOSHI.

Department of Botany,
Benares Hindu University,
March 31, 1936.

[1] *Bull. Acad. Sci., U.P.*, 1933, **3**.
[2] *Jour. Ind. Bot. Soc.*, 1934, **13**.
[3] *Proc. Ind. Acad. Sci.*, 1935, **1 B**.
[4] *Ibid.*, 1935, **2**.

A Preliminary Note on the Embryology of *Duabanga sonneratioides* Ham.

THIS note presents briefly the results of a detailed study of the embryology of *Duabanga sonneratioides*. This plant is a member of Sonneratiaceæ, one of those families of Myrtifloræ that has received very scant attention from students of angiosperm-embryology. So far the only species investigated, as cited by Schnarf[7] in his recent book, is *Sonneratia apetala* worked out by Karsten,[5] and this work dates as far back as 1891, besides being of fragmentary nature. Another point of interest relating to this family is that the genera included in it are placed by some systematists in the Lythraceæ and by others have been raised to the status of a separate family. Therefore it has been thought worthwhile to examine the embryological features of one of these genera.

The ovules are numerous and are borne on large axile placentæ. They are anatropous, with a fairly thick nucellus and two-integumented. Both the integuments take part in the formation of the micropyle. The primary female archesporium very frequently extends to more than one cell, and more than one functioning archesporial cells are occasionally met with. A parietal cell is cut off, which by subsequent divisions forms 4–5 cells thick parietal tissue above the embryo-sac. The megaspore-mother cell undergoes the heterotypic and homotypic divisions forming the normal linear tetrad. The homotypic division in the chalazal dyad usually precedes that in the micropylar dyad. The chalazal megaspore is the functional one and develops in the normal manner into an 8-nucleate embryo-sac after 3 successive nuclear divisions. The mature embryo-sac (Fig. 1) is 4-nucleate, just as in the Lythraceæ,[1,2,3,4,6,9] due to the early

Fig. 1.

Duabanga sonneratioides, Mature embryo-sac. × 1650.

degeneration of the antipodals. The synergids are hooked and have a small vacuole in their micropylar apex in addition to the usual very prominent chalazal vacuole,

A single nucleus is situated between the two vacuoles. The egg has the usual form.

The nucellus shows a chalazal strand of specially differentiated cells connecting the antipodal end of the embryo-sac and the vascular bundle of the ovule, just as in the Lythraceæ.[2,3,4]

The fertilisation is porogamous. The endosperm is nuclear in the early stages but becomes cellular in the later stages of seed development. The development of the embryo takes place according to the *Capsella* type and agrees in all essential points with that of the Lythraceæ.[4,8]

On the whole, the embryology of *Duabanga sonneratioides* shows a close resemblance with the embryological features of the Lythraceæ, which have been described in detail recently by Prof. Joshi and the writer.[1,2,3,4]

I desire to express my sincere thanks to Prof. A. C. Joshi for helpful suggestions during the progress of the work. I am also indebted to Mr. I. Banerji of Calcutta University for a part of the material used in this investigation.

J. VENKATESWARLU.

Department of Botany,
Benares Hindu University,
March 19, 1936.

[1] Joshi, A. C., and Venkateswarlu, J., *Ann. Bot.*, 1935, **49**, 196.

[2] Joshi, A. C., and Venkateswarlu, J., *Proc. Ind. Acad. Sci.*, 1935, **2**, No. 5.

[3] Joshi, A. C., and Venkateswarlu, J., *Proc. Ind. Acad. Sci.*, 1935, **2**, No. 6.

[4] Joshi, A. C., and Venkateswarlu, J., *Proc. Ind. Acad. Sci.*, 1936, **3**, No. 4.

[5] Karsten, G., *Bibl. Bot.*, 1891, **22**.

[6] Mavritzon, J., *Medd. Goteborgs Botaniska Trädgärd*, 1934, **9**.

[7] Schnarf, K., "der Angiospermen," Berlin, 1932.

[8] Souéges, R., *C. R. ac. Paris*, 1925, **180**.

[9] Tischler, G., *Ber. d. Deutsch. Bot. Ges.*, 1917, **35**.

Embryo Development in *Boerhaavia diffusa* Linn.

THE development of the embryo in *Boerhaavia diffusa* has been described by Dr. Maheshwari[1] to correspond to the *Capsella* type. This is wrong and the mistake has probably arisen on account of the incomplete observations of the various stages in development. It appears that 3 apical cells of the pro-embryo take part in the development of the embryo, excluding the root tip, and the embryo-development either corresponds to Chenopodiaceous or Caryophyllaceous type. Full details shall be published by the writer shortly elsewhere.

L. B. KAJALE.

Benares Hindu University,
April 4, 1936.

[1] Maheshwari, P., *Jour. Ind. Bot. Soc.*, 1929, **8**, 219–234.

The Ram Sarcophagus.

WHETHER the Sarcophagus from Sankhavaram described by me[1] is ram-shaped, is questioned by Mr. Govinda Menon[2] on the grounds that the head does not show the ears, the Sarcophagus has six legs, and the curling excrescences from the sides of the head are wings rather than horns. The rams among the bronze antiquities from Adichanallur are modelled without ears but with large horns as in the Sankhavaram Sarcophagus. As regards the number of legs, all cists of this size have more than four legs, as the potter's handiwork requiring more legs to support the torso of the animal than nature's. If a head removable from the torso were invested with a pair of "sturdy wings", the flighty head must have had a purpose we cannot trace. Were the whole object a bird, one would rather have expected that the wings would be attached to the torso, and not to the detachable head that could fly away leaving the torso and the bones behind. If the torso is bulkier in proportion to the head, it is because the torso, and not the head, was to be the receptacle for the bones.

I should therefore decline to follow in the wake of Mr. Govinda Menon when he passes on to speak of composite animals and the primitive mind.

Perhaps I may add that the Cochin Sarcophagus came to my notice shortly after my paper was prepared.

M. D. RAGHAVAN.

Government Museum,
Madras,
March 12, 1936.

[1] *Curr. Sci.*, 1935, **4**, No. 5.

[2] *Curr. Sci.*, 1936, **4**, No. 8.

The Vertebral Column of the Anura.

By Beni Charan Mahendra,
St. John's College, Agra.

WHILE looking through the first volume of *Current Science* at random the other day, I came across a note by Mookerjee[1] and an article by Ramaswami,[2] which have especially interested me. Both these authors appear to have started their investigations on the vertebral column of some frogs by a perusal of Nicholls' note[3] in *Nature* (1914) about the vertebræ of the genus *Bufo*, and to have assumed that no further papers existed on this subject criticising the older, more prevalent view of such authors as Boulenger (1897),[4] Gadow (1901)[5] and others. As a matter of fact, however, Beddard[6] in 1907 pointed out "the procœlous excavation of the vertebral centra" in *Megalophrys nasuta*, contrary to what Boulenger had believed, and Boulenger[7] himself in 1908 confirmed Beddard's finding and added, "but at the same time I find the vertebræ to be procœlous also in some specimens of *M. montana*, the type of the genus, and of *M. longipes*, of which species other specimens showed them to be opisthocœlous. It is therefore clear that the character, however important it may appear at first, is worthless even as a specific character in these Batrachians." In this connection, perhaps the most important work is a detailed article[8] by Nicholls in the *Proceedings of the Linnean Society of London* (1915–1), and unfortunately both Mookerjee and Ramaswami have overlooked it. Nicholls examined "practically the entire collection of Anuran skeletons in the British Museum," in all "over four hundred vertebral columns of some fifty genera of Anura"; and it is almost certain that a reference to his paper might have saved Mookerjee all the labour of preparing his note, and Ramaswami some unnecessary duplication of work.[9] A comparison of all the three articles shows that Mookerjee's observations on the eight vertebra of *Rhacophorus maximus* has been completely anticipated by Nicholls,[10] who seems to feel the inadvisability of admitting this genus into the family *Ranidæ*. He says:

"A more puzzling exception is met with in the genus *Rhacophorus*, and there can be, I think, in this case, no question of abnormality or individual variation.

"The genus is one in which Boulenger has merged the genus *Polypedates*, and it is represented, in the British Museum collection of skeletons, by nine specimens. Of these, four, belonging to the species *R. maculatus*, *R. cruciger*, *R. macrotis*, and *R. robustus*, were diplasiocœlous.[11] The remaining specimens, *R. maximus*, *R. madagascariensis*, *R. schlegelii*, and *R. reinwardtii*, were uniformly procœlous.[12]....

"Such a condition is apparently inexplicable in view of the fact that the *Rhacophori* are generally accepted as true Ranidæ. It is, however, of peculiar interest in view of the fact that the *Rhacophori* have not always been regarded as *Ranidæ*. Originally they were placed with the Hylidæ (which are of course procœlous), to which they bear a most remarkable resemblance which is, at the present time, attributed merely to convergence. How close is this resemblance may be judged from a fact

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[1] Mookerjee, H. K., *Curr. Sci.*, 1932, **1**, 165.
[2] Ramaswami, L. S., *Curr. Sci.*, 1933, **1**, 306.
[3] Nicholls, Geo. E., *Nature*, 1914. **94**, 420.
[4] Boulenger, G. A., "The Tailless Batrachia of Europe," 1897, p. 38.
[5] Gadow, H., "Amphibia and Reptiles," *Camb. Nat. Hist.*, 1901, 20 (reprinted in 1923).
[6] Beddard, Frank E., *Proc. Zool. Soc.*, London, 1907, **1**, 328.
[7] Boulenger, G. A., *Proc. Zool. Soc.*, London, 1908, **1**, 407.
[8] Nicholls, Geo. E., *Proc. Linnean Soc.*, London, 1915–16. Session 128, 80–92.

[9] I must admit, however, that Mookerjee and Ramaswami's work has a confirmatory value, and that Ramaswami has added materially to our knowledge in this respect.
[10] Nicholls, Geo. E., *op. cit.*, 1915–16, 89–90.
[11] The term "Diplasiocœlous" was suggested to Nicholls by Boulenger, and was proposed by Nicholls to designate "those vertebral columns, hitherto described as procœlous, which have *only the first seven* vertebral centra hollow in front, the eighth hollow upon both faces and the ninth doubly convex." The term is really good and should be employed more widely than it has so far been done.
[12] The term "*procœlous*" has been loosely used by most authors to designate even such a vertebral column as is found in *Rana*. Strictly speaking, it should be employed only to those cases where *all* the vertebræ have their centra concave anteriorly. This term has been used only in its correct sense in the present article, and it is hoped that other authors also will use it in its strict meaning so as to avoid needless confusion.

recently brought to light by Stejneger[13] (1907). This author has pointed out that the specimen originally figured by Schlegel and regarded as the type of *Polypedates* (*Rhacophorus*) *schlegelii* is actually a mere variety of *Hyla arborea* (*H. arborea japonica*). This view, he remarks (1907, p. 77), has been confirmed by an examination of the original specimen in the Leiden Museum. He figures this variety of *Hyla* as possessing the tongue typical of the Hylidæ but as having a foot which, so Mr. Boulenger informs me, is absolutely characteristic of *Rhacophorus*."

One should like to point out, however, that even if the genus *Rhacophorus* is shifted from the family Ranidæ to one of the families (*viz.*, *Bufonidæ*, *Hylidæ and Cysitgnathidæ*) forming the tribe *Procœla* of Nicholls, the difficulty is hardly solved, as this genus includes both procœlous and diplasiocœlous forms and a suitable explanation would then be required of the presence of the Ranid type of the vertebral column in some species of this genus.

Ramaswami's observations[14] fully confirm Nicholls' on the vertebræ of *Rhacophorus*, and also add *R. eques* to the diplasiocœlous, and *R. dubius* and *R. microtympanum*, to the procœlous forms. This latter author also feels the position of *Rhacophorus* as problematic and says: "Possibly an examination of other species of this genus may reveal a similar divergence and if it be so, then we have clearly included in this genus *Rhacophorus*, two groups which, so far as the character of the 8th and 9th vertebræ is concerned, will have to be dissociated. Whatever may be the nature of these vertebræ the transverse process of the 9th vertebra is typically Ranid in the forms examined by me, and this fact should not be lost sight of in the investigation of the other species of *Rhacophorus*."

Apparently in view of these studies, three questions arise bearing on the taxonomic status of the genus *Rhacophorus*, and we hope that later workers who have access to the necessary material, will throw some light on them. *First*, how far can we justifiably include within the same genus species so much differing from each other in the nature of their vertebral centra; *secondly*, is it really advisable to include this genus (or, at any rate, the strictly procœlous forms of it) in the family *Ranidæ*; and *thirdly*, how far are other features of organisation in the procœlous forms of this genus allied to such families as *Bufonidæ*, *Hylidæ* and *Cystignathidæ*, which are all grouped together as *Procœla* by Nicholls? It is not unlikely that the presence of both procœlous and diplasiocœlous forms in the same genus be due to a state of *plasticity* (as opposed to fixity of structure) on account of a recent state of evolution, and that the genus may help to bridge over the gap between the tribes *Procœla* and *Diplasiocœla* of Nicholls to some extent.

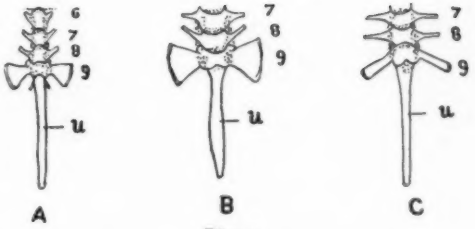

Fig. 1.

Ventral View of the hinder part of the Vertebral Columns of (A) *Discoglossus pictus*, (B) *Bufo andersonii*, and (C) *Rana tigrina*, to show the opisthocœlous, procœlous, and diplasiocœlous condition (After Nicholls).

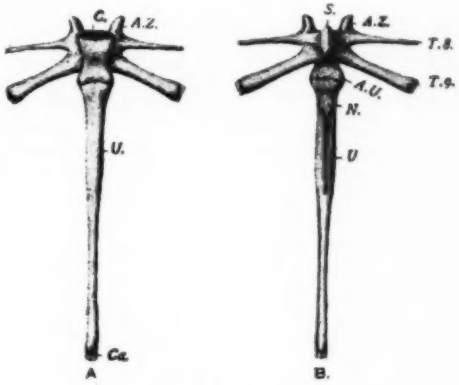

Fig. 2.

The fused 8th and 9th vertebræ and the Urostyle of normal *Rana curtipes*.

A. Ventral View. B. Dorsal View.

A.U., Articulation of the last vertebra with the urostyle; *A.Z.*, Anterior Zygapophysis; *C.*, Procœlous centrum; *Ca.*, cartilage; *N.*, Bony nodule on the urostyle; *S.*, Neural spine; *T. 8.* Transverse process of the 8th vertebra; *T. 9.* Transverse process of the 9th vertebra; *U.*, Urostyle.

[13] Stejneger, L., *Smithsonian Inst. Bull. U. S. Nat. Mus.*, 1907, No. 58, Washington.

[14] Ramaswami, L. S., *op. cit.*, 1933, 306.

Nicholls found that in his tribe *Diplasiocœla*, the species *Atelopus oxyrhynchus*, *A. ignescens* and *Rhombophryne testudo* belonging to the family *Engystomatidæ*,[15] as well as some species of *Rhacophorus* (*Ranidæ*), show the procœlous condition. To the procœlous types of *Ranidæ* examined by him, one can now add the following further species investigated by Ramaswami:

Ixalus chalazodes, *I. sylvaticus*, *I. nasutus*, *I. oxyrhynchus*, *Micrixalus saxicola*, *Nannobatrachus kempholensis* (n. sp., Rao).

Thus in our present state of knowledge, only the species of *Rana*[16] (except *R. curtipes*,[17] which has the eighth and ninth vertebræ fused together to form a synsacrum) and of *Nyctibatrachus*,[18] as well as the diplasiocœlous *Rhacophori* have a typically "ranid" type of vertebral column, Ramaswami's work having deducted three more genera from this group, and thus having further limited the strictly-defined "Diplasiocœla" of Nicholls. So the "ranid" type of vertebral centra does not seem to be prevalent even in the family *Ranidæ*, and it is necessary for every species to be carefully examined for this feature before a sound generalisation can be achieved. Our present knowledge of the vertebral column of Anura may be summed up as follows:

I. *Alossa*: vertebræ opisthocœlous.

II. *Phaneroglossa*:

(1) *Discoglossidæ* (Tribe *Opisthocœla* of Nicholls): vertebræ opisthocœlous; no exceptions recorded so far.

(2) *Pelobatidæ*: (Tribe *Anomocœla* of Nicholls): vertebræ procœlous. Exceptions are *Asterophrys*[19] and some species of *Megalophrys*,[20] which have opisthocœlous vertebræ.

(3) *Bufonidæ* — Grouped together as *Procœla* by Nicholls.

(4) *Hylidæ* — *Procœla* by Nicholls.

(5) *Cystignathidæ* — Vertebræ uniformly procœlous. No exceptions yet recorded.

(6) *Engystomatidæ* (Included by Nicholls in the Tribe *Diplasiocœla*): sacral vertebra biconvex, eighth vertebra biconcave, the first seven vertebræ procœlous. Exceptions are *Rhombophryne testudo*, *Atelopus oxyrhynchus* and *A. ignescens*.[21] Many genera, however, have yet to be examined.

(7) *Ranidæ* (included by Nicholls in the Tribe *Diplasiocœla*): The forms having the diplasiocœlous vertebral column, as far as is definitely known, are species of *Rana* (except *R. curtipes*) and *Nyctibatrachus major*, *N. pygmæus*, *N. sanctipalustris*, *Rhacophorus maculatus*, *R. eques*, *R. cruciger*, *R. macrotis*, *R. robustus*. The strictly procœlous forms are *Ixalus chalazodes*, *I. sylvaticus*, *I. nasutus*, *I. oxyrhynchus*, *Micrixalus saxicola*, *Nannobatrachus kempholensis*, *Rhacophorus maximus*, *R. madagascariensis*, *R. schlegelii* and *R. reinwardtii*. Many genera and species remain yet to be examined.

With regard to the nature of the vertebral centra as a useful feature in taxonomy and classification, Ramaswami says, "Judging by the inconstancy and arbitrary nature of the centra in these forms, I think that the character of such variable structures as the vertebra may not prove a very useful criterion in the classification of these forms." Such a view is supported by Boulenger[22] (1882, 1908), Gadow[23] (1901) and some

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[15] Nicholls examined only three specimens of this family belonging respectively to the three species *Atelopus oxyrhynchus*, *A. ignescens* and *Rhombophryne testudo*. Obviously, it is necessary to examine more specimens of each of these species, as well as of others, to put his conclusions on a firmer footing.

[16] Nicholls examined 160 specimens belonging to 33 species of this genus, while Ramaswami examined only 19 species. In all, if we allow for the species examined by both these authors, we find 50 species of *Rana* investigated for this feature. All but one of these conform to the diplasiocœlous type, the only normal exception being *R. curtipes*.

[17] Investigated by Ramaswami (1933).

[18] Only three species were examined by Ramaswami and they were *N. major*, *N. pygmæus*, *N. sanctipalustris*. All conformed to the diplasiocœlous group.

[19] Sedgwick, A., *A Student's Text-book of Zoology*, 1905, **2**, 310. With reference to the family *Pelobatidæ*, he says, "vertebræ procœlous except in *Asterophrys* and *Megalophrys* where they are opisthocœlous."

[20] Sedgwick's remark about this genus (see footnote 19) is to be modified in the light of Beddard, Boulenger and Nicholl's work.

[21] Only one specimen of each of these species was examined, and hence the necessity of confirmation by examination of more examples. All the three specimens examined had procœlous vertebra.

[22] Boulenger, G. A., "Catalogue of the Batrachia *Salientia s. Ecaudata* in the collection of the British Museum" (1882) and "A revision of the Oriental Pelobatid Batrachians (Genus *Megalophrys*)" (*Proc Zool. Soc.*, 1908.)

[23] Gadow, H., "Amphibia and Reptiles", *Camb. Nat. Hist.*, 1901, **8**. He says: "The systematic value of this pro- or opisthocœlous character has been much exaggerated" (p. 19), and further, "it is not difficult to imagine that in the Anura the production of Pro or and opisthocœlous vertebræ depends simply upon the centra articulating knobs happening to fuse either with the hind or the front end of the vertebræ," (p. 20.)

subsequent authors; while Nicholls[24] (1915–16) believes implicitly in the value of this character, and thinks that "the difficulty experienced in attempting to draw hard and fast lines between the different families suggests that our classification is, in the main, a natural one and does not represent merely a convenient key." Amongst the authors who laid stress on the nature of the vertebral centra as a valuable feature in amphibian classification, mention might be made of Cope[25] (1866), Lataste[26] (1879) and Blanchard[26] (1885).

In the end, I should like to express my deep sense of gratitude to Dr. S. C. Sarkar both for kindly presenting me his valuable collection of reference papers on this as well as on other subjects and for giving me much encouragement. Without the help of friends like him, my work would hardly be possible.

POSTSCRIPT.

After having written the foregoing article, I have been reminded of Whitehouse and Grove's explanation[28] of the biconvexity of the ninth vertebra in the frog. These authors feel that such a vertebra provides a much stronger base than a procœlous one could have done, and that it thereby fulfils the extra demand made upon its strength by the movement of the pelvic girdle. This view appears to be in contradiction to Gadow's notions[29] and to lose a great deal of its weight on account of the presence of a great many exceptions in the Anura.

[24] Nicholls, *op. cit.*, 1915–16, p. 91.
[25] Cope, E. D., *Jour. Acad. Sci., Pliad*, 1866, **6.**
[26] Lataste, F., *Actes Soc. Linn.*, Bordeaux, 1879, **33.**
[27] Blanchard, R., *Bull. Soc. Zool., France*, 1885.
[28] Whitehouse, R. H., and Grove, A. J., *Dissection of the Frog.* Univ. Tutorial Press Ltd., London, 1933, pp. 28–29.
[29] See footnote **23** above.

The Dead Sea: A Store-House of Chemicals.

IN a paper read before the Institute of Chemical Engineers, on March 6th, Mr. M. A. Novomeysky, read a paper on "the growth of the potash industry in the Dead Sea region" (*Chem. Age*, 1936, **34**, 235). The separation of a potash salt of the grade required by the markets (80–99 per cent. KCl) from the waters of the Dead Sea by solar evaporation, is an achievement involving numerous chemical engineering problems of the first magnitude. Results of experiments led to the conclusion that to produce a high-grade carnallite with a low content of sodium chloride the process of evaporation of the mother-liquor after the separation of the common salt, should be conducted in two or even three stages. In February 1930, the Palestine Potash Ltd., began constructional work with a view to extracting salts on a commercial scale. In 1931, a bromine plant was added. The present output is 25,000 to 30,000 tons of potash and 1,000 to 1,200 tons of bromine. A carnallite with the composition of 22·23 per cent. KCl and 8·96 per cent. NaCl decomposed after its first treatment with water into a sylvinite with 50·38 per cent. KCl and 20·75 per cent. NaCl and this after the first spraying with water yielded a product containing 78·1 per cent. dry KCl. With one or more sprayings, or treatment with brine saturated with KCl, the product can be brought up to a purity of 99 per cent. KCl.

The Study of Pedagogical Anthropometry of the Goan Students.

Statistical Summary.

By Prof. J. M. Pacheco de Figueiredo,
Medical College, Nova-Goa.

THE Liceu Central of Nova-Goa is a College for secondary education, having more than 600 students, 517 of whom were studied in the Medical Propedeutics Laboratory of the Medical College of Nova-Goa, and are here reported.

These students were divided in 3 groups (Indian Hindus, Indian Christians and Luso-Descendentes) and examined biometrically and medically.

This is a summary of our report which will be published in the "*Arquivos da Escola Medico-Cirurgica de Nova-Goa*".

Biometric Examination.

By this method we examined only normal students, after having scrupulously excluded ricketts.

The following tables show figures of the measurements taken by me in students from 11 to 18 years:

TABLE I.
Height.

Age	Indian Hindus	Indian Christians	Luso-descendentes
	cms.	cms.	cms.
11	..	130,1	..
12	137,2	135,1	138,7
13	143	143,7	144
14	146,9	150,7	146,8
15	111,6	156,9	155
16	157	158,6	159,4
17	160	162,4	164
18	159,2	163,9	164,5

TABLE II.
Chest.

Age	Indian Hindus	Indian Christians	Luso-descendentes
	cms.	cms.	cms.
11	..	65,3	..
12	67,5	66,7	69,4
13	72,5	71,1	72,3
14	73	74,1	74,9
15	75,6	77,6	77,3
16	79	78,2	81,3
17	81,1	81,7	83,4
18	81,4	82,9	84,4

TABLE III.
Weight.

Age	Indian Hindus	Indian Christians	Luso-descendentes
	Kgs.	Kgs.	Kgs.
11	..	25,740	..
12	30,297	27,690	30,380
13	33,086	32,330	34,280
14	34,738	36,980	38,450
15	38,837	40,980	41,000
16	41,928	43,000	49,000
17	42,000	47,900	49,709
18	45,324	47,460	50,630

TABLE IV.
Thoracic Circumferences.
(*Axilar**)

Age	Indian Hindus			Indian Christians			Luso-descendentes		
	Max. mm.	Min. mm.	Dif. mm.	Max. mm.	Min. mm	Dif mm.	Max. mm.	Min. mm.	Dif. mm.
11	..	..	..	625	608	17	..	..	..
12	656	633	23	641	615	26	648	630	18
13	673	652	21	677	648	29	682	649	33
14	701	675	26	714	680	34	727	664	63
15	726	700	26	751	728	23	737	697	40
16	763	737	26	760	740	20	790	758	32
17	800	774	26	816	779	47	823	778	45
18	808	760	48	804	759	45	813	787	26

* Across the armpits.

TABLE IV (*b*).
Thoracic Circumferences.[1]
(*Maximum and Minimum.*)

Age	Indian Hindus			Indian Christians			Luso-descendentes		
	mm.	mm.	mm.	mm.	mm.	mm.	mm.	m.m.	mm.
11	..	..	..	608	580	28	..	..	..
12	650	618	32	634	592	42	649	608	41
13	653	620	33	662	620	42	686	636	50
14	683	646	37	690	641	49	717	662	55
15	700	666	34	720	672	42	722	670	52
16	730	687	43	736	687	49	770	716	54
17	757	719	38	778	720	58	788	730	58
18	742	704	38	754	698	56	810	734	76

[1] At the level of xyphoid process.

TABLE V.

Abdominal Circumferences.[2]

Age	Indian Hindus	Indian Christians	Luso-descendentes
	mm.	mm.	mm.
11	..	538	..
12	561	557	569
13	565	577	596
14	587	588	622
15	605	603	613
16	606	619	654
17	638	640	662
18	624	624	648

[2] At the level of navel.

TABLE VI.

*Iliac Circumference.**

Age	Indian Hindus	Indian Christians	Luso-desendentes
	mm.	mm.	mm.
11	..	578	..
12	605	586	598
13	598	612	621
14	619	615	648
15	636	647	648
16	651	650	677
17	653	678	690
18	666	676	687

* At the level of the iliac crest.

TABLE VII (*a*).

Thoracic Diameters.

(*Axilary.*)

Age	Indian Hindus					
	A. Post			Transversal		
	Max.	Min.	Dif.	Max.	Min.	Dif.
11	..	..	..	..	..	..
12	134	122	12	191	178	13
13	139	125	14	192	176	16
14	138	122	16	205	188	17
15	153	139	15	206	191	15
16	152	137	15	215	201	14
17	154	140	14	227	212	15
18	157	140	17	222	205	17

Age	Indian Christians					
	A. Post.			Transversal		
	Max.	Min.	Dif.	Max.	Min.	Dif.
11	135	123	12	176	165	11
12	134	119	15	183	168	15
13	140	122	18	195	175	20
14	145	130	15	200	178	22
15	153	134	19	216	196	20
16	152	139	13	219	198	21
17	156	138	18	233	210	23
18	158	136	22	237	209	28

Age	Luso-descendentes					
	A. Post.			Transversal		
	Max.	Min.	Dif.	Max.	Min.	Dif.
11	..	..	..	..	..	..
12	143	124	19	184	160	24
13	143	124	19	202	179	23
14	158	138	20	204	175	29
15	151	130	21	213	179	34
16	163	138	25	219	194	25
17	166	145	21	235	206	29
18	165	138	27	243	208	35

TABLE VII (*b*).

Thoracic Diameters.[1]

Age	Indian Hindus					
	A. Post			Transversal		
	Max.	Min.	Dif.	Max.	Min.	Dif.
11	..	..	..	..	..	..
12	148	137	11	214	198	16
13	155	142	13	215	201	14
14	163	148	15	220	200	20
15	170	152	18	225	202	23
16	170	153	17	226	211	15
17	175	158	17	217	228	19
18	172	153	19	238	216	22

Age	Indian Christians					
	A. Post			Transversal		
	Max.	Min.	Dif.	Max.	Min.	Dif.
11	156	146	10	201	188	13
12	150	135	15	209	191	18
13	151	137	14	219	197	22
14	171	151	20	226	202	24
15	170	151	19	239	215	24
16	166	147	19	244	215	31
17	172	150	22	254	226	28
18	170	146	24	245	217	28

Age	Luso-descendentes					
	A. Post			Transversal		
	Max.	Min.	Dif.	Max.	Min.	Dif.
11	..	..	..	..	..	..
12	159	139	20	219	164	55
13	166	143	23	230	206	24
14	171	150	21	239	207	32
15	180	152	28	244	209	35
16	186	153	28	250	211	39
17	188	160	28	252	221	31
18	169	155	14	270	219	51

[1] At the level of xyphoid process.

TABLE VIII.

Bi-Acromial Diameter.

Age	Indian Hindus	Indian Christians	Luso-descendentes
	mm.	mm.	mm.
11	..	273	..
12	297	284	294
13	300	307	297
14	318	318	317
15	326	335	317
16	344	352	340
17	359	357	349
18	350	355	351

TABLE IX.

Antero-Posterior Diameter of Abdomen.

Age	Indian Hindus	Indian Christians	Luso-descendentes
11	..	140	..
12	144	146	140
13	145	152	152
14	147	150	157
15	155	154	160
16	152	159	163
17	161	156	159
18	155	151	160

TABLE X.

Bi-iliac Diameter.

Age	Indian Hindus	Indian Christians	Luso-descendentes
	mm.	mm.	mm.
11	..	195	..
12	207	195	215
13	213	215	222
14	214	222	231
15	229	236	237
16	240	245	245
17	244	241	250
18	237	242	246

TABLE XI (*a*).

Circumference of Fore-arm.

(*Maximum.*)

Age	Indian Hindus		Indian Christians		Luso-descendentes	
	right	left	right	left	right	left
	mm.	mm.	mm.	mm.	mm.	mm.
11	..	..	180	172	..	..
12	185	180	180	177	187	182
13	191	185	190	180	191	187
14	197	193	202	197	205	200
15	216	200	210	204	207	203
16	220	211	213	210	232	226
17	227	225	227	222	233	224
18	224	221	224	220	236	228

TABLE XI (*b*).

Circumference of Fore-arm.

(*Minimum.*)

Age	Indian Hindus		Indian Christians		Luso-descendentes	
	right	left	right	left	right	left
	mm.	mm.	mm.	mm.	mm.	mm.
11	..	..	117	114	..	..
12	124	122	118	117	121	118
13	124	123	124	122	127	125
14	128	128	133	132	137	134
15	132	132	136	134	135	134
16	137	136	138	136	150	147
17	143	142	145	144	148	143
18	141	141	143	141	150	147

TABLE XII.

Dynamometry.

Age	Indian Hindus arm		Indian Christians arm		Luso-descendentes arm	
	right	left	right	left	right	left
	Kg.gr.	Kg.gr.	Kg.gr.	Kg.gr.	Kg.gr.	Kg.gr.
11	..	..	12,300	10,600	..	..
12	18,800	16,100	16,400	13,300	16,200	15,000
13	19,500	17,200	17,300	16,100	19,300	16,000
14	20,300	17,000	24,000	20,000	20,700	18,500
15	25,500	23,300	27,600	23,300	27,200	24,000
16	30,400	25,700	29,600	26,200	31,600	27,200
17	33,100	28,500	37,300	31,500	41,000	32,500
18	33,900	29,600	34,600	27,000	41,800	34,500

TABLE XIII.

Spirometry.

Age	Indian Hindus	Indian Christians	Luso-descendentes
	L. cl.	L. cl.	L. cl.
11	..	1, 38	..
12	1, 59	1, 67	1, 86
13	2, 1	1, 98	2, 18
14	2, 22	2, 81	2, 39
15	2, 44	2, 71	2, 90
16	2, 76	2, 92	3, 16
17	2, 89	3, 07	3, 49
18	2, 91	3, 28	3, 97

MEDICAL EXAMINATION.

(1) HEREDITY.

No elucidating data were obtained.

(2) PREVIOUS HISTORY.

The incidence of infectious diseases in the 3 groups is as shown below :—

Diseases	Hindus	Indian Christians	Luso-descendentes
Measles ..	73,39%	77,87%	72,72
Small-pox ..	4,92%	2,65%	1,13%
Whooping-cough ..	45,81%	58,85%	60,22%
Diphtheria ..	1,47%	2,21%	5,68%
Parotites ..	31,62%	30,08%	31,81%
Typhoid-Para-typhoid infections	28,05%	24,33%	14,77%
Malaria ..	16,74%	23,00%	35,22%

The incidence of Infectious diseases in the total number of the students examined :

Percentages.

Measles .....74·85%
Small-pox ..... 3·28%
Whooping Cough .....53·96%
Diphtheria .....2·51%
Parotites.....30·94%
Typhoid-Paratyphoid ..... infections .....24·33%
Malaria .....22·63%

(3) DIET.

The following were the percentages of different diets :

Vegetarian diet : 3·28. Vegetarian and fish diet : 8·31. Mixed diet : 88·39.

The high percentage of mixed diet is due to the inclusion of Hindu students in this group who, though rarely, eat flesh.

(4) DIGESTIVE SYSTEM.

(*a*) *Examination of the mouth.*—We inspected the roof of the mouth and the condition of teeth. We did not find students with ogival vaults. After carefully examining the teeth we adopted our own classification in which the letter C represents dental caries, the letter F the missing parts, the indices indicate their respective numbers.

Good.—Teeth without signs of caries and well attended to.

Regular .—Teeth with tartar, caries or missing parts not exceeding 2. This group contains the following formulas : C^1, C^2, F^2, C^1F^1.

Bad .—Teeth with caries or missing parts, not exceeding 5 in all.

In this group there are the following formulas :—C^3, C^4, C^5, C^2F^1, C^1F^3, C^2F^2, C^2F^3, C^3F^1, C^3F^2, C^4F^1.

Very bad.—Teeth with pyorrhea, with caries or missing parts exceeding 5 in all.

In this group there are the following formulas :—C^6, C^3F^3, C^4F^2, C^4F^3, C^5F^1, C^5F^2, C^5F^3, C^5F^4, C^6F^1, C^6F^2, C^6F^1, C^6F^2, C^6F^7, C^8F^1.

Based on our classification we found the following condition of teeth : *Good* 38·10 ; *regular* 32·30 ; *bad* 22·63 ; *very bad* 6·97.

Here is the comparative table of the percentages in the 3 groups :—

Groups	Normal teeth	Teeth with caries, missing parts or tartar
Hindus ..	47,78	52,22
Indian Christians ..	34,95	65,05
Luso-descendentes	23,86	76,13
Total examined ..	38,10	61,90

(*b*) *Examination of pharynx and of the tonsils.*— This examination resulted in the following observations : (1) Unilateral hypertrophy of tonsils, (2) Bilateral hypertrophy of tonsils, (3) Adenoids, (4) Other diseases of pharynx.

The following are the percentages of each group :

Groups	Hypertrophy of the tonsils		Adenoid vegetations	Other diseases of Rhino-Pharynx
	Unilateral	Bilateral		
Hindus ..	19,21	12,80	5,91	..
Indian Christians ..	20,79	11,06	7,52	..
Luso scendentes	30,68	22,72	5,68	1,13

Here are the percentages in the total number examined :

Hypertrophy of the tonsils (Unilateral)	21,95%
Hypertrophy of the tonsils (Bilateral)	13,34%
Adenoid vegetations	6,57%
Other diseases	0,19%

(*c*) *Examination of the Intestines.*—We aimed at finding out the incidence of constipation and diarrhœa. Here are the results :

Groups	Normal	Constipation	Diarrhœa
Hindus ..	98,57	1,47	..
Indian Christians ..	93,36	6,63	..
Luso-descendentes	90,90	9,09	..

(*d*) *Hernia Regions.*—We found only one student, Luso-descendente, with inguinal hernia.

(5) RESPIRATORY SYSTEM.

Beyond the thoracic measurements nothing noteworthy of mention.

(6) CIRCULATORY SYSTEM.

(*a*) *Examination of the pulse.*—This examination was conducted with the student lying in bed.

The percentage of tachicardia was of 18·71 in Hindus, 22·56 in Indian Christians and 21·59 in Luso-descendentes, the percentage in relation to the total number examined being 20·88. The percentage of bradi-cardias was 3·09.

(*b*) *Heart examination* .—This examination consisted of auscultation and determination by palpation and percussion the position of the apex. The students were observed in both standing and dorsal positions. The following was the percentage of abnormalities (murmurs, extra-systoles, hypertrophies) found : *Hindus*, 13·3; *Indian Christians*, 5·79 ; *Luso-descendentes*, 5·68. In our report we discussed and analysed the cause of these hypertrophies which can be generally attributed to (1) Athletic exercises and to sports without previous physical training. (2) Excessive cycling. (3) The staircase of the Liceu of 140 steps which the students must climb everyday. (4) Intellectual overwork. (5) Infectious diseases. (Typhoid fever and rheumatism.)

(*c*) *Efficiency of the Heart.*—The test which we made use of was the step-proof of Lian used with brilliant success in French methods. We found 4 Indian Christian students and 1 Hindu with fair cardiac sufficiency.

(*d*) *Blood Pressure.*—We determined the blood pressure of all the students by Boulitte-Korotkow spygmanometer. The blood pressure is, in general, higher in Hindus. The normal range in Indian Christians and Luso-descendentes, of 12 to 20 years, is of 10 to 12 cm. Hg. to P. mx. and 6 to 8 cm. Hg. P mn. while in Hindus it oscillates between 11 to 13 P. mx. and 7 to 9 P.mn. The predominant differences of the pressures are 4 to 5 cm. Hg. in all three groups :—

(7) GENITO-URINARY SYSTEM.

The following is the table of the percentages of general diseases.

Groups	Varicoceles	Hydroceles	Orchitis
Hindus ..	1,97	0,98	1,96
Indian Christians ..	3,54	0,44	1,32
Luso-descendentes	4,54	1,13	1,13
Total examined ..	3,09	0,77	1,54

We noted also some congenital malformations : two cases of undescended testicles in the inguinal canal ; one case of the testicular atrophy : one case of triorchidia ; two cases of infantile penis with proeminent pubis and rudimentary labia majora.

(8) SKIN DISEASES.

The following was the distribution of skin diseases : Hindus, 8·86. Indian Christians, 7·08. Luso-descendentes, 2·27. In relation to the total number examined : Sane, 93·03, Skin diseases, 6·93.

(9) LYMPHATIC SYSTEM.

The table with the distribution of ganglionary hypertrophy is the following :—

Groups	Normal	Cervical	Epitroclears	Inguinal
Hindus ..	38,42	17,22	6,40	11,33
Indian Christians ..	26,10	23,89	2,21	12,83
Luso-descendentes	32,95	26,13	3,40	6,81
Total examined ..	32,10	21,66	4,06	11,21

Groups	Cervical & Epitroclears	Cervical & Inguinal	Epitroclears & Inguinal	Cervical Epitroclears & Inguinal
Hindus ..	4,43	12,80	3,44	5,91
Indian Christians ..	1,77	27,43	1,32	4,42
Luso-descendentes	3,40	14,77	3,40	9,09
Total examined ..	3,09	19,53	2,51	5,80

(10) SKELETON.

(*a*) *Deviation of Vertebral Column.*—The Table of the distribution of the percentages is the following :—

Groups	Normal	Kyphosis	Scoliosis	Lordosis
Hindus ..	52,21	22,16	25,61	..
Indian Christians ..	51,32	23,89	24,33	0,44
Luso-descendentes	53,40	20,45	26,13	..
Total examined ..	52,03	22,44	25.14	0,19

(*b*) *Deformities of the Bones.*—The most common deformities we found were rachitic thorax. Its distribution was : Hindus 5·91; Indian Christians 11·50; And Luso-descendentes 7·95. Total examined 8·70.

(*c*) *Anomalies.*—We registered an interesting case of second stage of hectrodactillea with the absence of metacarpals and fingers.

(11) EYES.

The examination of sight was made by the Vicker's optometric scale. Here is the Table :—

Groups	Short-sighted	Without correction of sight
Hindus ..	24,77	66,07
Indian Christians ..	16,74	79,44
Luso-descendentes	18,18	68,75
Total examined ..	20,05	70,74

(12) EARS.

The examination of auditory acuteness was made with a "Longines" clock. Considering that the majority of students hear the tic-tac of the clock at a distance of 45 to 70 cms. and taking this ear as a normal one, we established the following classification :

	cms.
Excellent: ear, hearing at a dist. of	100 to 75
Normal ,, ,, ,,	70 to 45
Weak ,, ,, ,,	40 to 15
Bad ,, ,, ,,	10 to 0

The table with the distribution of the percentages according to our classification is the following :—

Hearing Capacity	Hindus		Indian Christians		Luso-descendentes	
	ear		ear		ear	
	right	left	right	left	right	left
Excellent	13,79	12,80	14,16	15,48	25,00	22,73
Normal	48,28	47,79	48,67	51,78	52,28	56,82
Weak	35,46	35,96	33,62	30,97	19,32	20,45
Bad	2,47	3,45	3,55	1,77	3,40	0

Research Notes.

The Longest Convex Curve Described about a Convex Polygon.

MAYER (*Crelle's Journal*, Bd. 174, Heft **3**, pp. 125–128) has solved this interesting problem by means of a very simple analysis. First of all, for a triangle, a quadrilateral, and for all polygons for which the sum of any two consecutive angles is $< \pi$, there are convex curves circumscribing them of as great a length as we like. Therefore, the problem will be of interest for all polygons which do not belong to the above category; *i.e.*, if $p_1p_2 \ldots p_np_1$ is the polygon $p_i + 1p_i$ and $p_{i-2}\ p_{i-1}$ should meet when they are produced in the way that is indicated; let the triangle that is obtained by adding $p_{i-1}\ p_i$ as a side be denoted by D_i. If K is the polygon, then it is obvious that the perimeter of every circumscribed convex curve is $<$ that of the polygon (not convex of course) $K + \Sigma D_i$. Hence, the existence of the curve follows. (By means of a procedure analogous to the proofs of the classic results in the theory of normal family of functions.) By means of a nice elementary geometrical analysis he has proved that the convex curve is found among the polygons $M = K + \Sigma\epsilon_i D_i$ ($\epsilon_i = 0$ or 1). It is obvious that the following conditions should be satisfied (1) $\epsilon_i = 1$, then $\epsilon_{i-1} = \epsilon_{i+1} = 0$. (2) If $\epsilon_{i-1} = \epsilon_{i+1} = 0$ then $\epsilon_i = 1$; so that the number of different polygons among which we have to search for the longest is appreciably less than 2^n. If $g(n)$ is their number then it is easy to show that $g(n) = g(n-2) + g(n-3)$ (formally put $g(-1) = -1$, $g(0) = 3$, $g(1) = 0$.

K. V. I.

Class-Number Relations of Binary Quadratic Forms in Quadratic Fields.

LUBELSKI (*Crelle's Jour.*, Bd. 174, Heft 3, pp. 160–184) has found out the number of classes of quadratic forms whose coefficients belong to an imaginary quadratic field $K(\sqrt{-q})$, (we assume that $q \geqslant 3$, throughout. He has also found out the corresponding relations for the Gaussian field) the number of ideal classes of which are *odd*. If H is the number of classes of quadratic forms with integral coefficients out of $K(\sqrt{-q})$ and discriminant $D = 4D'$[D' *quadrat-frei* in $K(\sqrt{-q})$,] and h and h' are the number of classes of quadratic forms with discriminant D and $-qD$, respectively then $H = hh'$ or $2hh'$ according as $x^2 - Dy^2 = -1$ is solvable in natural numbers are not. In the first part of his work he has solved the problem for quadratic forms whose coefficients are integral ideals of $K(\sqrt{-q})$. The results in this case are mostly analogous to the classical results connecting ideal classes of $K(\sqrt{-q})$ and the rational quadratic forms with discriminant $-q$; we have to consider a relative quadratic field and ideal classes relative to $K(\sqrt{-q})$. Signifying as a real ideal class, a class in which the quadratic forms with integral numbers out of $K(-\sqrt{q})$ as coefficients, it is interesting to note that Lubelski has given examples of relative fields in which all the classes of quadratic forms with integral ideal coefficients are equivalent to the real classes alone.

In the second part, he proves the final result by means of a series of lemmas. A summary of the proof is the following. (Note that $q > 3$ and that the number of ideal class is assumed to be *odd*.) He has first of all considered quadratic forms of two types—the first type consisting of all quadratic forms of the form $ax^2 + bxy + cy^2$ and the second of the form $ax^2 + b\sqrt{-q}\,xy + cy^2$. (Discriminant D, a, b and c natural integrals.) He has shown that equivalence of the quadratic forms of the first type in the rational as well as in $K(\sqrt{-q})$ is the same. [This theorem is true even if the class-number of $K(\sqrt{-q})$ is *even*); and if a form of the first type is transformable into a form of the second type in $K(\sqrt{-q})$, then the form should be equivalent to an *ambig* form and conversely. Next, he has shown that every quadratic form with rational coefficient and discriminant $-Dq$ can be transformed by means of a suitable transformation to one of the second type; and that the product of two forms of the first or second types are equivalent to forms belonging to the same type. By means of a lemma he has connected the equivalence of two forms of the second type with one of the first type with the reduction of the corresponding forms with discriminant $-Dq$ to the form $ax^2 + aq\rho xy + cy^2$ [$\rho = 0$ or 1]. Afterwards he has determined the number of non-equivalent forms which are products of a form of the first type and another of the second type in terms of h, h' and r, the odd

prime factors of D'. Next he has defined (analogous to the rational case) the characters of a class of quadratic forms; and he has determined the necessary and sufficient conditions in order that a quadratic form with coefficients out of K ($\sqrt{-q}$) is capable of representing natural numbers; first of all, it should be a product of two forms of the first and second types respectively. The second condition depends on characters (Norm-residue symbols of Hilbert). By means of these intermediate theorems the exact number of classes of quadratic forms, mentioned in the beginning is determined.

K. V. I.

An Apparent Failure of the Photon Theory of Scattering.

IT is well known that A. H. Compton has explained the scattering of X-Rays by free electrons, assuming that the collision between an X-Ray photon and an electron would be governed by the principles of conservation of energy and momentum. One of the consequences of this photon theory of scattering is that the recoil electron and the scattered photon should appear at the same instant. R. S. Shankland (*Phys. Rev.*, **49**, 8) has examined whether this coincidence is true in the region of incident γ-ray quanta. He employed specially constructed Geiger-Müller tubes in two directions for the recoil electrons and the scattered photons respectively, such that the angle between the directions is given by the photon theory of scattering. He also chose the directions of the counters at different angles. Providing necessary arrangements to record coincident discharges in the electron and the photon counters and employing γ-rays from radium-C, he found that the observed coincidences are quite small compared with the expected coincidences and also that the observed coincidences are rather due to the scattered γ-ray quanta entering the electron counters and discharging secondary electrons from the counters. Thus Shankland opines that there are no genuine coincident discharges at all. In reviewing Shankland's results, Dirac (*Nature*, **136**, 298) seems to think that they demand a revision of the theory of the interaction between matter and radiation without perhaps the principles of the conservation of energy and momentum.

N. S. N.

Raman Effect in Chemical Dynamics.

IN the March number of *Physica*, p. 154, W. F. Buzhold and L. S. Ornstein present an interesting report of the applications of Raman spectra methods to a study of chemical reactions, such as the oxidation of transformer oils and the photo-chemical chlorination of chloroform to carbon tetrachloride. A calibration curve for the latter was drawn up by plotting the intensities of the carbon tetrachloride Raman lines against the amount of carbon tetrachloride present in a mixture of chloroform and carbon tetrachloride. The graph was a straight line. The experimental results are discussed in great detail in relation to the dynamics of the reaction. It is suggested that highly unstable chain products could be detected by Raman spectra, as unlike the ultra-violet and infra-red absorption spectra, the former is an integrating effect.

M. A. G. RAU.

New Radioactive Transformations produced by Bombardment of Uranium by Neutrons.

THE discovery of trans-uranic elements by Fermi and his co-workers and its confirmation by Meitner have already been noticed in *Curr. Sci.*, 1935, **3**, 376. Meitner and Hahn have recently studied the various products obtained by bombarding uranium with neutrons and by comparing the activities produced by fast neutrons and slow neutrons (slowed down by passage through paraffin) they have reached interesting conclusions regarding the processes that occur (*Naturwiss.*, 1936, **24**, 158). The radioactive properties of elements 93 (Eka-Re), 94 (Eka-Os) and 95 (Eka-Ir) have been thus determined. The processes envisaged as leading to the production of these elements are the following:

(1) $U^{239} + n \rightarrow Th^{235} + \alpha$; $Th^{235} \xrightarrow{\beta} Pa^{235} \xrightarrow{\beta} U^{235} \xrightarrow{\beta}$ Eka-$Re^{235} \rightarrow$?

(2) $U^{238} + n \rightarrow U^{237} + 2n$: $U^{237} \xrightarrow{\beta}$ Eka-$Re^{237} \xrightarrow{\beta}$ Eka-$Os^{237} \xrightarrow{\beta}$ Eka-Ir^{237} ?

(3) $U^{238} + n \rightarrow U^{239}$; $U^{239} \xrightarrow{\beta}$ Eka-$Re^{239} \xrightarrow{\beta}$ Eka-$Os^{239} \xrightarrow{\beta}$ Eka-Ir^{239} ?

The following table summarising their results is taken from their paper.

Atom	Half-value period	Produced by
Th^{235}	4 min.	Slow neutrons
Pa^{235}	Very short ?	Slow ,,
U^{235}	24 ± 2 min.	Slow ,,
U^{237}	40 sec.	Fast ,,
U^{239}	10 sec.	Better by slow ,,
Eka-Re^{237}	16 ± 1 min.	Fast ,,
Eka-Re^{239}	$2{\cdot}2 \pm 0{\cdot}2$ min.	Better by slow ,,
(Eka-Os^{237}) ?	12 hrs.	Fast ,, ?
Eka-Os^{239}	59 ± 2 min.	Better by slow ,,
(Eka-Ir^{239}) ?	3 days	?

T. S. S.

On the Structure of Cosmic Radiation.

THE nature of the radiation which gives rise to the showers observed by Blackett and Occhialini has been a somewhat disputed question. The primary cosmic radiation is now accepted to be corpuscular and is denoted by the letter A in Geiger's notation. The shower-producing radiation seems not directly to produce ionisation and may be some kind of γ-radiation. Whether it is a B-radiation, *i.e.*, one produced directly by the primary A-radiation, has not been so far settled. Now R. Hilgert and W. Bothe (*Zs. f. Physik*, 1936, **99**, 353) describe experiments which show that the shower-producing radiation is a B-radiation produced in the matter near the earth. Besides this they show that this B-radiation itself comes in the form of bundles so that it is now clear why it should produce showers. The experimental method was to count the number of double coincidences recorded by two counters kept side by side when a lead sheet was placed above one or the other of them and when lead sheets were placed over neither or both. The radiation was allowed to fall on the lead sheets once directly and once after passage through a carbon filter. It was found that when the radiation had first passed through the carbon, the increase in the number of coincidences observed with lead sheets on both counters was much larger than the sum of the increases observed when one or the other counter had a lead sheet over it. When the radiation fell directly, however, the increase in the number of coincidences due to a lead sheet on either counter was much larger than before but the increase when lead sheets were placed over both counters was simply the sum of the increases due to each sheet separately. These results are explained by assuming that the shower-producing radiation must have started in bundles from a distance corresponding to its range. When the carbon filter was employed the bundles should have come from somewhere near the filter and thus fallen in almost parallel paths on the two lead sheets simultaneously producing showers therein. When the radiation came directly, however, it should have started at a much larger distance corresponding to the range in air, so that the bundles would have diverged sufficiently not to fall simultaneously on the two lead sheets. This explanation was further confirmed by observing quadruple coincidences with four counters, one pair of which was above the other.

T. S. S.

Atomic Weight of Gallium.

LUNDELL AND HOFFMAN (*J. Research of the National Bureau of Standards*, October 1935), starting with a quantity of metallic gallium, previously prepared by one of the authors and the purity of which was estimated to be at least 99·999 per cent., have determined its atomic weight.

Known quantities of this very pure metal were dissolved and converted into the hydroxide, sulphate, and the nitrate, these salts being subsequently ignited to the oxide and weighed. This procedure enabled the calculation of the atomic weight of gallium with direct reference to that of oxygen.

The suitability of metallic gallium as well as that of its oxide for work of this type was established after a careful exploration of the sources of error which were likely to occur, and these included, (*a*) occluded gas in the metallic gallium employed, (*b*) oxide film on the metal, (*c*) presence of minute traces of chlorides in the metal, (*d*) constancy in weight of gallic oxide after ignition and its hygroscopicity, (*e*) occluded gas in the

ignited gallic oxide, and (*f*) constancy in weight of platinum crucibles when heated for long periods at 1200–1300° C.

The averages of the three sets of values obtained from the experiments with the hydroxide, nitrate and the sulphate were respectively $69{\cdot}73_7$, $69{\cdot}73_5$, and $69{\cdot}73_7$. The rounded value 69·74 is therefore put forward for the atomic weight of gallium.

K. R. K.

Vitamin B_6.

IMPORTANT studies on that part of the Vitamin B_2 complex which is responsible for the cure of the specific dermatitis developed by young rats fed on Vitamin B-free diet supplemented by purified Vitamin B_1 and lactoflavin, have been reported from the Cambridge University, by Birch and György (*Biochem. J.*, 1936, **30**, 304). In fish muscle and wheat germ this Vitamin appears to be attached to a protein as a prosthetic group and for quantitative extraction, it is necessary to autolyse the tissue digest with papain. The Vitamin is not precipitated by salts of lead, mercury or silver, or by picric acid, but is precipitated by phosphotungstic acid; it is soluble in ethyl alcohol but is not extracted from a concentrated watery solution by acetone, amylalcohol or ether. Fuller's earth adsorbs the Vitamin from acid solutions, and during electro-dialysis it migrates towards the cathode. Vitamin B_6 appears therefore to be of a basic nature, and, from the fact that it can be inactivated by benzoylation but not by the action of nitrous acid, it is suggested that it does not contain a primary amino-group, but that it possibly possesses a hydroxyl group.

Hastening Germination of Acacia Seeds by Soaking in Boiling Water.

EXPERIMENTS reported in the *Agricultural Gazette of New South Wales*, **47**, Part I, show that for effective and rapid germination in the case of certain acacias (*Acacia Baileyana*, *Acacia aneura*, and *Acacia elata*) soaking in boiling water is found very satisfactory. In the case of the first it was found that even six years old seed will not germinate unless the hard outer coat is softened by intense heat. Untreated seed was compared with (1) seed soaked in cold water for thirty minutes, (2) seed soaked in cold water and the water then brought to the boiling point, (3) water brought to the boiling point and seed immersed and allowed to remain for ten minutes with the heat turned off, and (4) seed placed in boiling water and boiling continued for ten minutes. It was found that the germination in the last three treatments was from 80 to 90 per cent. while the cold water soaking and the control gave less than 10 per cent. It also made very little difference if the seed was only two years old or was six years old.

Cement Concrete for Grain Storage Bins.

QUITE a useful application of cement concrete construction in agriculture is its use for the construction of underground grain bins or granaries. (N. C. Mehta in the *Agriculture and Livestock in India*, **6**, Part I.) The very primitive but, at the same time, very general practice of storing grains like *ragi* and *jola* in underground straw-lined pits common in Mysore has its counterpart in the storage of wheat in Upper India. Here, however, the storage is on a very large scale being adopted by the important and large grain merchants for the holding up of grain intended for sale; it is not the small domestic affair such as prevails in Mysore. Both are however subject to the same drawbacks in regard to damage and deterioration and especially where the soil is unsuitable or the season excessively wet. A loss of some four lakhs of rupees is reported during the very rainy year 1933 in the grain stores of Muzafarnagar, while the danger of the damaged grain getting into the hands of poor people and being used as food was an even more serious matter. The Concrete Association of India has taken up the matter and already some 200 cement storage cisterns are said to have been constructed for the grain merchants of that large trade centre. The cost per 100 cubic feet of storage space is put down at about Rs. 33, with cement at Rs. 52–8–0 per ton, sand and single at Rs. 20 per ton each. While for the grain trade the regular well-equipped grain elevators usual in other countries will be the most suitable type of large-scale storage bins designed to meet modern conditions of transport, these underground concrete cisterns are certainly a great improvement and will suit the needs of the smaller individual trader. For the ordinary cultivator too it is a desirable improvement to adopt and does not appear too costly.

Studies on the Nature of Disease Resistance in Cereals.

APPLICATION of nitrogenous fertilisers has been recognised to increase severity of rust attack in cereals. It is maintained by Gassner and his co-workers in Germany that an increased supply of N, leads to an increase in the availability of protein in the plant, conducive to rust development. Johnson and Johnnson (*Canadian J. Res.*, 1935, **13,** 355) analysed mature and immature tissues of the wheat plant to ascertain if the latter are richer in organic N than the former, as it is recognised that the immature tissues are more susceptible to stem rust than the full-grown tissues. Analyses of N in six varieties showed that the N-content was greater in the mature tissues than in the immature ones. The greater susceptibility of the younger leaves cannot be attributed to a higher organic N-content, unless it is assumed that the N is present in a more utilisable form than that of the older leaves.

In a previous paper, the authors showed that the young tissues were richer in sugars than the older ones (*Canadian J. Res.*, 1934, **11**). It is concluded that the resistance of the mature tissues to rust cannot be explained on a purely nutritional basis.

M. J. N.

The Virus of Sugarcane Mosaic.

INTERESTING studies of the Sugarcane Mosaic Virus both in the laboratory and in the field are reported in the *Indian Journal of Agricultural Science*, **5**, Part VI. A study of the physical properties by S. A. Rafay brings out that (1) like the crinkle mosaic of the potato the cane mosaic virus tolerates a 1 in 10 dilution and that by a dilution of 1 in 100 and above the virus entirely loses its potency; (2) it loses its potency in two hours in contrast with the spotted wilt of tomato which does so in six hours and the tomato mosaic virus which remains viable for years; (3) no infection is obtained with a filter paper filtrate or the Chamberlain candle filtrate, while the green residue left on the filter paper is infective; and (4) it is one of the most sensitive of viruses and shows the least resistance to chemical reagents; thus copper sulphate 1 in 1500, hydrochloric acid 1 in 1000, nitric acid 1 in 800, mercuric chloride 1 in 1000, sodium chloride 1 in 25, hydrogen peroxide 1 in 25, and formalin 1 in 50, all inactivated the virus. It is noted with interest that an oxidising agent (hydrogen peroxide, Merck's) had no effect on the virus in 1 to 50 parts, while Johnson (1926) found even a resistant type like the tobacco mosaic virus to be sensitive to the inactivating effect of oxygen.

Field studies in the Punjab by J. C. Luthra and Abdus Sattar covering a period of three to six years show the following, *viz.*, (1) only the primary symptoms, *i.e.*, mottling of leaves occur in the Punjab and that the secondary symptoms, *i.e.*, the dwarfing of the canes, etc., are not observed; (2) the amount of infection on any particular variety varies from place to place and that some varieties are more infected than others, observations having been made on about 45 varieties nearly all of them cotypes; (3) the canes show the first symptoms about a month and a half after planting and that the infection goes on increasing till October; (4) in the variety Co. 223 (during three years' observations) no decrease in the yield of cane, juice or gur occurred as the result of mosaic nor was there a deterioration in the quality of the juice; and (5) that roguing can keep the disease within limits in those varieties only which are not very susceptible to mosaic.

Detergent Action of Soluble Silicates.

SILICATE solutions have been used as cleansing agents in a variety of ways, and the advantages of employing soluble silicates is of great importance to those interested in detergent technique. The different aspects of this problem has been studied by Vail in a recent paper (*Ind. Eng. Chem.*, 1936, **28,** 294). The effect on the pH values of solutions by variation of the $Na_2O : SiO_2$ ratio, as also by changes in concentration, have been investigated. The advantage of employing sodium silicate for cleaning metallic surfaces at higher temperatures, without appreciable corrosion, has been pointed out. So far as bactericidal effect is concerned, silicate solutions are more effective than soaps. The silicate solutions are better deflocculating agents than soaps and their wetting power is also decidedly better. They are good emulsifying agents when mixed with soaps and are technically employed in the preparation of asphalt

emulsions. It is therefore clear that sodium silicate is no longer thought of as an adulterant to soap, but as a useful adjunct in improving its properties.

M. P. V.

The Skull of the Therocephalia.

A MINUTE study of the cranial characters of the mammal-like reptiles of the group Therocephalia forms the subject of an important paper by R. Broom (*Phil. Trans. Roy. Soc. Lond.*, B, March 1936, **226**, No. 529, 1-42). The study has been made by means of sections of these fossil forms all of which belong to South African Permian beds. The importance of this group cannot be overestimated as it is highly probable that the "line of mammalian descent passed through some members of the Therocephalia". The skull, which is remarkably like that of a mammal in structure, includes factors like heterodonty and a temporal arch formed of the jugal and the squamosal. But the differences are none the less striking. The place of the single median vomer of the mammal is taken in the Therocephalids by a pair of bones situated well behind and probably homologous with the dumb-bell-shaped bone of Ornithorhynchus. The quadrate is still a very pronounced bone and the lower jaw is still a compound structure.

Geological Aspects of Underground Water-supply.

IN discussing the underground water-supply of England in a series of three Cantor Lectures delivered at the Royal Society of Arts (*Journal of the Royal Society of Arts*, Feb. 1936, **84**), Dr. Bernard Smith has shown that this water-supply is largely dependent upon rainfall, evaporation and percolation. The large quantity of water which percolates downwards is utilised partly by plants and mineral substances; but the greater portion is stored up under suitable conditions in rocks. The availability of this water depends upon several factors like porosity, perviousness and joints. Several rocks, such as coarse sandstone, clay and chalk, are highly porous and hence contain a large supply of water. The igneous rocks have an average porosity of only 1 to 2%, but yet such of them as are highly jointed and fissured like the Indian basalts contain a steady supply of water as shown by Dr. Fox.

With the help of sketches, Dr. Bernard Smith has also referred to the development of Artesian wells and the factors which control the water-supply in them. The chief water-bearing strata of England are the Carboniferous limestone, millstone grit, coal measures, inferior oolites and great oolites. The geological factors which control the underground water-supply are faults, flexures and missing formations. It is thus obvious that the underground water supply is beset with numerous difficulties and usually it requires the co-ordination of the geologists and the water supply engineers to locate suitable spots for successful operation.

Some Alkaline Rocks of the Shansi Area, N. China.

AT a time when the problem of the genesis of the alkaline rocks is being widely discussed, it is interesting to observe that the Nystrom Institute for Scientific Research in China has published (E. T. Nystrom, *Bull. Geological Institute of the University of Upsala*, **22**) a very comprehensive account of the alkaline rocks of Shansi. This area is equal in size to England and Scotland combined, and the alkaline rocks were first discovered here by E. T. Nystrom in 1910. This part of North China has been divided into three important tectonic divisions. In the central portion, where the trend lines of the tectonic system meet, are developed a series of dislocations which have resulted in the eruption of the alkaline rocks.

The alkaline rocks themselves are distributed in three distinct regions and they occur mostly as laccoliths or stocks either in the archæns or in the later sedimentary rocks, such as shales and limestones. In the latter case the sediments have been metamorphosed, accompanied by an abundant development of calc-silicates. In some cases huge blocks of limestones have been caught up by the intruding magma and they have been burnt and rendered powdery. According to the author, the intrusions seem to have taken place in the mid-tertiary period.

There is a striking similarity in the sequence of eruptions in the different localities,

and the parent magma seems to be of an akeritic composition as in Oslo (Christiania) and Hobart (Tasmania). This akeritic magma shows evidences of differentiation in three distinct branches—granitic, syenitic and dioritic. It is evident that by the elimination of the granitic differentiate a large quantity of the silica content has been removed; and there has been a considerable impoverishment of plagioclase and femic minerals by the dioritic differentiate. The residual syenitic magma has been the source for the evolution of the more alkaline types, such as nordmarkite, nepheline syenite, leucite syenite, tinguaite, etc. The paper contains a large number of analyses, charts, figures and calculations of great petrographic value. This is the first time that such a detailed presentation of the alkaline rocks of the Shansi area is made and it is bound to be of great interest to all igneous petrologists.

Progress of Science in India.

IN the course of his address welcoming the delegates to the Joint Session of the Scientific Societies held at Bangalore (10th-14th April), Sir C.V. Raman, KT., F.R.S., N.L., pointed to three ideals which should guide research workers to secure for India a prominent place in the scientific map of the world. A fastidious attention to a high standard of quality in scientific research constitutes the first ideal; weeds shall have no place in the garden of science and, to ensure a steady and wholesome growth and development, the weeds must be scrupulously kept out. The second ideal is to recognise the essential unity of knowledge. Science should not be conceived in terms of water-tight compartments even as a matter of administrative expediency. Administrative separatism leads to intellectual separatism and eliminates that essential factor which makes for intellectual co-operation among scientists pursuing different branches of knowledge, a co-operation which is necessary for the fruitful progress of science. Many of the outstanding discoveries have been made in laboratories which have stood for such an ideal, and where several scientific subjects are studied in close juxtaposition. To cite one instance, the discovery by von Laue, of the diffraction of X-rays, was made possible in the favourable environment provided by the Munich Laboratory where such stalwarts like Prof. Sommerfeld, the eminent mathematical physicist, and Prof. Granz, the famous mineralogist and crystallographer, were working. Lastly, it is necessary to recognise the leadership which mathematical thought possesses in the progress of science. It is utterly futile to evaluate science on the gold standard. There is an amazing contempt for scientific work which does not bring an immediate monetary return. "With all the emphasis I can command, I sound a note of warning of the dangers of this attitude," said Sir C. V. Raman. "The deeper and fundamental aspects of science appeal to but a few who possess a disciplined attitude of mind. No progress can be achieved in any branch of science if we lose our respect for, or withhold support to, the fundamental sciences of Mathematics and Philosophy; the more we neglect these the less we advance." Research, not founded on fundamental mathematical concepts, is like food devoid of vitamin, that entity which makes all the difference between calories and nutriment.

Stratosphere Flight in the Balloon "Explorer".*

GAY-LUSSAC was probably the first scientist to go up in 1804 into the earth's atmosphere in a hydrogen-filled balloon to obtain accurate knowledge of it *in situ*. Since then there have been, at various times, a number of balloon flights; some have been successful, but others have ended in tragedy and death.

But the spectacular and successful flight in 1931 of Auguste Piccard, the pioneer of balloon ascensions, in a sealed metal gondola, became the forerunner of the subsequent series of balloon flights in Russia, Belgium and the U.S.A.

The publication under review gives, in a series of articles, the details of the flight into the stratosphere of the giant balloon *Explorer* on 28th July, 1934. This expedition was organised jointly by the National Geographic Society and the Army Air Corps of the U.S.A. and is a wonderful example of co-operative effort in the cause of science by a large number of scientists and private and public organisations and individuals.

The object was to collect accurate information about the variations with height of temperature, pressure and humidity, wind velocity, compositions of air, the ozone layer, the directional intensity of cosmic rays, altitude measurements, colour of sky, etc.

The large number and variety of specially designed, highly intricate instruments and associated equipment were all arranged suitably in a sealed magnesium alloy (Dowmetal) spherical gondola, 9 feet in diameter, till it was really a densely packed, multi-purpose, floating laboratory with its own radio telephone (transmitting and receiving) equipment for continuous communication with the earth below.

To lift this great weight with three men inside to a height of some 75,000 feet above sea, the balloon was designed to have the gigantic volume of about 3,000,000 cubic feet, standing some 300 feet when partially inflated and changing into a spherical shape of 180 feet diameter high up. The covering was of rubberised cotton fabric and entirely without a single stitch over its whole area of over 11,000 square yards.

The various beautifully illustrated technical papers on the design, construction and operation of the balloon, gondola, cosmic ray apparatus, spectrographs, barometers, cameras, etc., by outstanding men like Millikan, Swann, Briggs and others are most interesting and instructive to read even for the lay reader. Every detail of every piece of apparatus and mechanism was worked out with meticulous care and precision to secure maximum safety for the fliers and the balloon, and the smooth and efficient working of everything over the extremely varying physical conditions during the flight.

Despite all this, and of the fact that the three fliers were outstanding airmen, the great balloon started to give way at 11 miles above earth and ended in disaster for the balloon, the gondola and all the many beautiful apparatus inside it. Only the fliers saved themselves by jumping out with their parachutes.

It is impossible to withhold admiration for the great composure and utter disregard of personal safety shown by the heroic fliers over the prolonged period of over two hours from the moment when they first noticed the rent in the balloon fabric when at a height of 57,000 feet. Fully realising the extreme and instantaneous hazard to life at any moment, they attended to their respective duties throughout with a cool courage and devotion to work that are beyond praise.

Highly interesting as are the technical articles, no reader, lay or learned, can read unmoved the graphic story of the flight by Captain Stevens and the shorter report by Major Kepner. The numerous excellent photographs help to give a strikingly vivid picture of the various stages of the flight.

Not the least remarkable feature of the expedition was the part played by radio. From the beginning to the last moment when the fliers jumped out of the detached gondola hurling down to the earth, there was perfect two-way radio telephone communication between the gondola and the earth. The millions of listeners throughout the United States followed from minute to minute the thrilling events of the flight and the last minute escape of the airmen.

Of the results of the expedition, the publication does not say very much as, with the gondola, all the valuable records with the exception of a few were destroyed.

All the observations show that the *Explorer* reached a maximum altitude of a little over 62,000 feet. Altitudes by the barometric formula and the vertical camera photographs agree with each other remarkably well (page 23). Wind velocity varied from a value of 70 miles per hour at 42,000 feet blowing from north-west to 28 miles at 50,310 feet and in the same direction; but at about 60,000 feet, it dropped to 10 miles per hour and in the opposite direction, blowing from south-east.

Temperature fell with height in proportion to the logarithm of the pressure upto about 150 mm. of mercury (page 21); with a reduced rate of fall, a minimum temperature of $-62°$ C. was reached at the height corresponding to 75 mm. of mercury. Further up, a rise in temperature occurred.

Cosmic rays increased in intensity with height and with inclination to the horizontal (pages 12, 13, 423).

Altogether a very readable account of an excellently planned daring enterprise which deserved better luck. It will be with no small interest that the report of the recent successful flight of *Explorer II* will be expected.

R E

* The National Geographic Society—*U. S. Army Air Corps Stratospheric Flight of 1934 in the Balloon 'Explorer'*; Published by the National Geographic Society, 1935.

Band Spectra and Valency.*

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ELECTRONIC CONFIGURATIONS.

THE vibrational analysis of the band system of a diatomic molecule gives the vibrational frequency ω and the factor of anharmonicity ωx and according to the formula $D = \frac{\omega^2}{4\omega x}$ the dissociation energy D of each of the two electronic states involved. It is mostly possible also, to obtain an idea as to the character of these terms, *e.g.*, from considerations of the emitter and the number of heads each individual band possesses. The internuclear distance r_0 can also be estimated by certain empirical formulæ and this as well as the character of the terms can be definitely confirmed by the detailed rotational analysis of the bands.

In analogy with the spectra of atoms we distinguish these terms by their multiplicity and by the value of a quantum number, which represents the total orbital angular momentum along the nuclear axis of the molecule. Thus we get Σ, Π, Δ, etc., if this quantum number $\Lambda = 0, 1, 2$, etc. The multiplicity is indicated by a superscript thus $^1\Sigma$, $^2\Sigma$, $^3\Sigma$, etc., which means that the spin quantum number S has the values 0, $\frac{1}{2}$, etc., the multiplicity (number of sub-levels) being given by $2S + 1$.

This description is not complete, but sufficient for the purpose of the present subject, which is the electronic configuration of the molecule. There are two ways to construct the wavefunction of a molecule. The first method has been developed mainly by Heitler, London, Slater, and Pauling, and is therefore known as the H.L.S.P method.[1] This method constructs the wavefunction of the molecule from those of the separated atoms or their valence electrons and accordingly arrives at the character of the molecular electronic term from considerations of the constituting atomic terms. The second method, originated by Lennard-Jones and developed by Herzberg, Hund, and Mulliken, is called the method of molecular orbitals and starts from the very beginning with the completed molecule, *i.e.*, with the atoms at their proper internuclear distance and constructs the wavefunction of the molecule from those of its constituent electrons. The first method naturally is better suited for the description of the molecule at large internuclear distances, while the second one is so at smaller distances. Both of these have their own advantages; thus the H.I.L.S.P. method appears to be superior, as far as questions of energy are involved, whereas the orbital method is more suited to the description of the electronic configuration and term scheme of the molecule. We shall therefore take up the latter view-point and base the following remarks on the method of molecular orbitals.

Accordingly, we start with the system of the two positively charged nuclei at a fixed distance and introduce into the resulting field the electrons of the molecule individually one after the other. A molecule is distinguished from an atom because its field possesses a favoured direction; this corresponds to the behaviour of an atom in a strong electric field and the quantum numbers of the electrons therefore are the same as those of the Stark effect. Each single electron is characterised by an axial quantum number λ, which shows, how much each electron contributes to that of the total angular momentum Λ and which is identical with the Stark effect quantum number m_l of the atoms. The electrons are called $\sigma, \pi, \delta \ldots$. electrons, if λ is 0, 1, 2.... in analogy to the *s*, *p*, *d* electrons of the atoms. They form quantum groups or "orbitals" and the maximal number of electrons in a σ group is 2, that in the π group 4, because this includes the values $m_l = +1$ and -1. In a polyatomic molecule, however, the two directions parallel and antiparallel to the field are no longer degenerated, and the π group is split into two pairs. The molecule CH, for instance, with its 7 electrons, may be considered as a N atom, whose nucleus is divided into two parts, of which one possesses 6, the other one, 1 charge, and which are slightly separated from each other. The two 1*s* and the two 2*s* electrons of N can become σ electrons only, because, for $l = 0$, $m_l = \lambda$ can have no other value but 0. The *p*-electrons, however, can become σ or π electrons, because for $l = 1$, $m_l = \lambda$ may have the values 0 and ± 1. If we denote by superscripts the number of electrons in each group (if more than one is present), we obtain the following electronic configurations for the CH molecule:—

$$1s\sigma^2 \quad 2s\sigma^2 \quad 2p\sigma^2 \quad 2p\pi.$$

Of the three *p* electrons, the first two have populated the $p\sigma$ group, the third, not finding a place there according to Pauli's principle, has gone into the $p\pi$ group. The order, in which the orbitals are written, is an energetical order. The more we proceed towards the right-hand side, the less energy is necessary, to ionise the molecule. This way of writing gives us also the contribution of each electron to Λ. At the same time each electron contributes $\frac{1}{2}$ to the spin quantum number S. For both quantum numbers, however, we have not to pay regard to the electrons on the closed orbitals, here the first three, because all the vectors are counterbalanced, and the character of the ground term of CH is determined only by the single π-electron. Two vectorial positions of L and S are possible and the term is a $^2\Pi$ term. In the molecule HF, three electrons more are present and fill the three empty places in the $2p\pi$ orbital. Its electronic configuration is, according to that of the Ne atom,

$$1s\sigma^2 \quad 2s\sigma^2 \quad 2p\sigma^2 \quad 2p\pi^4.$$

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* Presidential address, delivered in the Physical Society, Aligarh, March 26th, 1936.

[1] References of the theoretical investigations will be found more or less complete in the following papers: J. H. Van Vleck and A. Sherman: *Rev. Mod. Phys.*, **1935, 7, 167**; R. S. Mulliken, *J. Chem. Phys.*, **1935, 3, 375**; H. Lessheim and R. Samuel, *Proc. Ind. Ac. Sci.*, (Bangalore), **1935, 1, 623**. For experimental results *cf.* W. Jevons, Report on Band Spectra, London, **1932**, and H. Sponer, *Molekulspektren*, Berlin, **1936**.

The number of papers which are connected with this subject, is very large and only a few having a direct bearing on the controversial points are quoted in detail.

This configuration is only made up of closed groups and the quantum numbers are $\Lambda = 0$ and $S = 0$, the resulting state is a $^1\Sigma$ term.

In this description, treating CH as N and HF as Ne, we have used the conception of the "united atom", *i.e.*, we have assumed, that the two nuclei are so close to each other, that they nearly coincide. It is assumed, that the field still resembles a central field as in an atom, so much so that the quantum numbers n and l of the atom retain their significance. This is true among the hydrides because they possess particularly small internuclear distances, the proton having no dimensions in the ordinary sense. We are thus able, to use these known quantum numbers to determine the unknown ones of the molecule. Generally, however, the field does not possess an approximately central character, but has only axial symmetrie. Then it is not possible, to imagine the distance between the two nuclei shortened more and more, till the molecule becomes a "united atom" because the quantum numbers of the latter one have lost their significance for the actual molecule. In this case we have to determine the values of λ from the quantum numbers of the separated atoms. In the symbols $1s\sigma$, etc. just as we have written the quantum numbers n and l of the "united atom", before the λ of the molecule, so we shall now write the corresponding n and l values of the separated atoms behind λ and get for the lowest orbitals, again in energetical order,

$\sigma(1s)\ \sigma(1s)\ \sigma(2s)\ \sigma(2s)\ \pi(2p)\ \sigma(2p)\ \pi(2p)\ \sigma(2p)$

The configuration of the ground state of the molecule NO, in which we have two $1s$ groups, two $2s$ groups and together seven p-electrons, is $\sigma^2(1s)\ \sigma^2(1s)\ \sigma^2(2s)\ \sigma^2(2s)\ \pi^4(2p)\ \sigma^2(2p)\ \pi(2p)$ and the term, exactly as that of CH, is a $^2\Pi$ term. The two groups $\sigma(1s)$, *i.e.*, the K shells of N and O, remain for all practical purposes localised in the neighbourhood of their own nuclei and form so called "atomic orbitals". The configuration proper of the molecule is formed by the following electrons of the L shell, which in this case are on "molecular orbitals". From this distinction the whole method has received its name.

PREMOTED AND NON-PREMOTED ELECTRONS.

From the above it will be seen that the energetical order of the electronic groups in the molecule is different for the two methods of interpolation, viz., from the view-point of the "united atom" and from that of the separated system. For small internuclear distances we obtained the order $\sigma\sigma\sigma\pi\sigma\sigma\pi\ldots$, for bigger ones $\sigma\sigma\sigma\sigma\pi\sigma\ldots$. The reason for this is the operation of Pauli's principle. Two separated atoms like C and O possess each a completed K shell, *i.e.*, together four $1s$ electrons. But the corresponding united atom, in this case Si, can have only one $1s^2$ group. If we consider the CO molecule as an interpolation between the two extreme cases, and shorten the distance between the two atoms more and more, two of the four $1s$ electrons have to find during this process a place somewhere else in the electronic configuration of the two centre system. As a matter of fact, these two electrons will of course remain as σ electrons, but will form the group $2p\sigma$ in the united atom. In other words, if we have the two nuclei stripped of all electrons and fixed once at a small and once at a large internuclear distance and let in the electrons now being recaptured by them, we get different configurations. If the distance is large (the field of axial symmetry) the third electron becomes a $1s$ electron. If the distance is small (approximate central symmetry), the third electron will go into the group $2s$. Similar considerations apply to other groups, and this rearrangement of the groups can be seen, if we write the electronic configuration of a molecule with all quantum numbers, namely those of the "united atom" as well as those of the separated system. That of NO may serve as an example:

$1s\sigma^2(1s)\ \ 2p\sigma^{*2}(1s)\ \ 2s\sigma^2(2s)\ \ 3p\sigma^{*2}(2s)\ \ 2p\pi^4(2p)$
$3s\sigma^2(2p)\ \ 3d\pi^{*}(2p).$

Among the electronic groups there are three (marked by asterisks), which on increasing internuclear distance go into higher orbitals, from $1s$ to $2p$, from $2s$ to $3p$, from $2p$ to $3d$ respectively. Such electrons are called "premoted" the other ones non-premoted. The energetical relation between the orbitals at various values of r was first calculated for H_2^+ and later generalised for other molecules by Hund, and is shown in the diagram of Figure 1. This correlation table

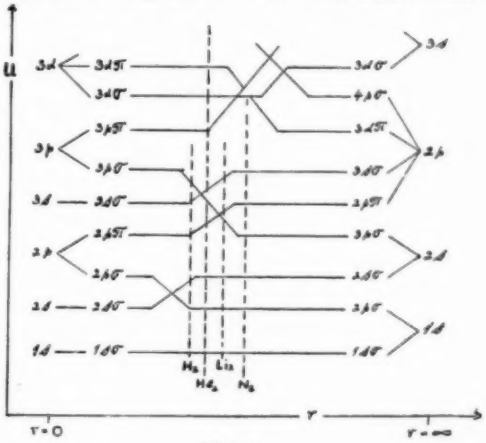

Fig. 1.

indicates the energetical order of the molecular orbitals for any internuclear distance from $r = 0$ to $r = \infty$. For a number of molecules the probable value of r is indicated and going along the dotted line, we can read off the series of electronic groups. At the same time the different heights of the groups above the abscissa indicates the energy. It can be seen that the energy to tear off the electrons generally decreases with increasing quantum numbers and, furthermore, that on decreasing internuclear distance the system of two atoms loses energy by the process of premotion and gains energy by the non-premoted groups. A premoted group is bound with less energy than the corresponding non-premoted one.

THE PROCESS OF DISSOCIATION.

From the character of the term we construct such electronic configurations, which yield the required S and Λ values. The energies of excitation and dissociation(calculated from the harmonic and anharmonic constants) indicate, from which

term of the atoms in question the level of the molecule arises and gives us the quantum numbers of the electrons in the separated atoms. In this way it is mostly possible to select the true electronic configuration from among the possible ones.

In the case of a diatomic molecule we know that its potential energy can be expressed as a function of the internuclear distance between its constituent atoms. We thus obtain, as Franck pointed out first, the potential energy curve, which runs parallel to the axis of the internuclear distance so long as the system represents two separated atoms. This curve will show a minimum if the two atoms enter into chemical combination to form a molecule, but it will have no minimum in the case of an elastic impact of the two atoms, which does not lead to chemical linkage. If one or both of these atoms are excited from the very beginning of molecular formation, then the horizontal part of the curve is higher by an amount which is given by the excitation energy of the atom or atoms concerned. If now the atoms combine to form a molecule, we obtain the curve of potential energy of an excited electronic level which again may or may not exhibit a minimum. In this way we may obtain a number of potential energy curves for a molecule which represent the various electronic levels of the molecule in different electronic configurations. The potential energy curves which do not show a minimum also come under this category.

Let us consider the lowest of such potential curves. Its trough represents the various vibrational energy levels that belong to the molecule and here the equilibrium position or roughly the minimum of the curve indicates the internuclear distance in that state of the molecule, where it is in its lowest vibrational level. The difference in the energy between this position and the position of the separated atoms gives the dissociation energy D″ of the molecule. If the molecule absorbs light of a certain energy ν_0 its electronic configuration is changed and we obtain an excited term. Its energy of dissociation D′ correlates it with the level of the separated atoms of which now, at least in many cases, one is excited. The difference $\nu_0 + D' - D''$ equals the energy of excitation of this atom. Thus in H_2 (Fig. 2) the ground-level $^1\Sigma$ has the electronic configuration $1s\sigma^2$ and the dissociation energy 4.47 volts. By removing one electron into an excited group, the term $1s\sigma\ 2p\sigma\ ^1\Sigma$ obtains, ν_0 being 11.13 volts, $D' = 3.47$ volts. The difference $\nu_0 + D' - D'' = 10.15$ volts gives the energy difference of the separated system and agrees very well with the energy of the first line of the Lyman series at 1215·7 A.U. Hence the ground-level is formed by two normal H atoms both in the term $1\ ^2S$, the excited level of the molecule by one normal and one excited atom in the term $2\ ^2S$. In both states of the molecule the electrons counterbalance their spin, the two molecular states being singlet terms. If two normal H atoms approach each other the electrons having parallel spin, a $^3\Sigma$ level results, which is a repulsive term, the $U : r$ curve not possessing any minimum. This term is the final level of the continuous emission spectrum of hydrogen.

To take another example, the above configuration of the ground state of NO contains four $2s$ and seven $2p$ electrons and therefore arises

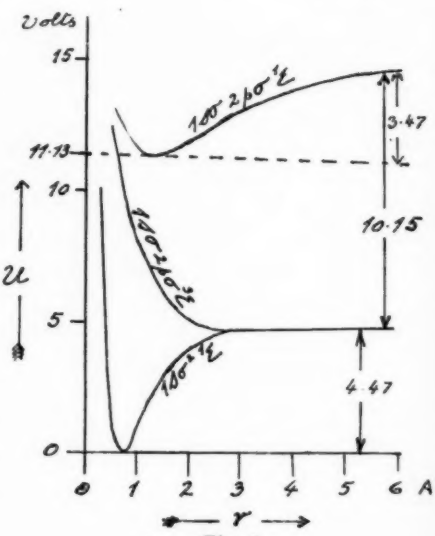

Fig. 2.

from the combinations N $(2s^2\ 2p^3)$ + O $(2s^2\ 2p^4)$, which are those of the unexcited atoms. But

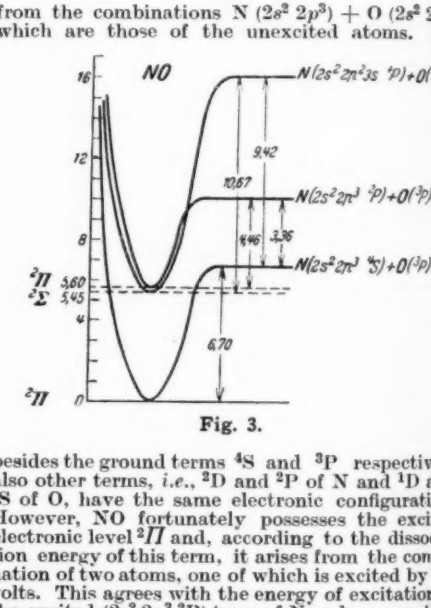

Fig. 3.

besides the ground terms ^4S and ^3P respectively also other terms, *i.e.*, ^2D and ^2P of N and ^1D and ^1S of O, have the same electronic configuration. However, NO fortunately possesses the excited electronic level $^2\Pi$ and, according to the dissociation energy of this term, it arises from the combination of two atoms, one of which is excited by 3·4 volts. This agrees with the energy of excitation of the excited $(2s^2\ 2p^3\ ^2P)$ term of N and proves that the ground-level of the molecule is formed by two unexcited atoms. A third term of NO, $^2\Sigma$, is interesting, because its energy of dissociation is bigger than that of the ground-level. It is correlated to O $(2s^2\ 2p^4\ ^3P)$ + N $(2s^2\ 2p^2\ 3s\ ^4P)$. The electronic configuration of the molecule in this state is therefore (if we abbreviate the atomic orbitals of the K shells by K_1 and K_2) :—

$K_1\ K_2\ 2s\sigma^2$ $(2s)$ $3p\sigma^2$ $(2s)$ $2p\pi^4$ $(2p)$ $3s\sigma^2$ $(2p)$ $-3s\sigma$ $(3s)$.

We find that the partial removal of the odd $3d\pi$ $(2p)$ electron increases the energy of dissociation, or in other words, if the electron, which later on remains unpaired in the molecule, is already removed to the M shell in the N atom, a molecule with an increased bond energy is formed. This interpretation, confirmed by the bands of PO, AsO and SbO, appears to be important for a theory of valency.[2]

In similar ways we learn that the s^2 group of the earth alkali metals acts repulsively. The ground state of the molecules of the BeO and BeF type does not arise from the combination of unexcited metal atoms in the term $s^2\,{}^1S$ with O and F, Cl, etc., but from that of excited metal atoms in the term $sp\,{}^3P$, the helium-like s^2 group having been previously fissured. This result is of interest, because it shows, that also a non-premoted group may act repulsively. For some time, because the extrapolation of the dissociation energy is never entirely accurate, this result was doubted, but to-day it is proved in two ways. Some of the molecular terms have to be correlated to terms of atoms, in which two electrons are excited simultaneously (the so-called anomalous terms) and this shows that already one electron was excited in the dissociation products of the ground-level. A clear decision is furthermore given by the spectrum of CdF. Here the energies of excitation of the metal are increased, Cd belonging to the sub-group of the Periodic Table and therefore the only possible correlation proves beyond doubt that the metals of the second group are chemically inert, so long as the s^2 group of electrons remains undisturbed.[3]

Development of the Orbital Method to a Theory of Valency by the Introduction of New Postulates.

Proceeding from the description of the electronic configuration and term system of the molecule, to questions of valency, we shall again take up the view-point of the method of molecular orbitals. Here, however, the answers furnished by the theory are not so clear as for the problems dealt with above. Whereas these latter concerned the completed molecule, *i.e.*, the system of two atoms at small internuclear distances, for which the method of molecular orbitals is singularly adapted, questions of valency invariably involve the process of dissociation (or its converse, the process of formation) of the molecule, *i.e.*, are dealing with the same system at large internuclear distances, which is already somewhat outside the scope of the orbital method.

If two atoms undergo chemical combination, the ground state of the molecule possesses a potential curve with a minimum at a particular internuclear distance. Only by means of introduction of energy it is then possible either to increase or to decrease the distance of the two atoms and the minimum of the $U:r$ curve is therefore the necessary condition of molecular formation. Any theory of valency on the basis of band spectroscopy has therefore at first to show, which of the curves of the possible electronic configurations possess a minimum and which not, or, in other words, which of them is an attractive curve and which a repulsive one. The next step will then be, to find out, what distinguishes the wavefunctions of the attractive terms from those which belong to the repulsive ones.

The method of molecular orbitals as such does not furnish any answer to both these questions at the present state. It is not qualified to distinguish between the attractive and repulsive curves nor to give the amount of energy of dissociation. The reasons, as we shall see, are inherent to this method; they are connected with its general inability to describe the system at larger internuclear distances and due to the same principle which brings about its advantages, *i.e.*, that the interaction of the electrons does not play any part in it. It is therefore necessary to introduce new conceptions into the method of molecular orbitals, but from the very beginning it should be emphasized, that such a procedure means the *introduction of new postulates*, and it is not on the method of molecular orbitals but on these postulates, that the theory of valency is based.

The first postulate, introduced particularly by Herzberg and Mulliken, is, to identify premoted and non-premoted electrons with anti-bonding and bonding electrons respectively. A premoted electron of a molecule is bound with less energy than the corresponding non-premoted one. It is assumed, that a premoted or non-premoted electron tends to make the $U:r$ curve repulsive or attractive respectively. The $U:r$ curve of the particular molecule is conceived to be made up from the single terms of the single electrons, the correlation table indicates the loss or gain of energy per single electron and as a matter of principle it is assumed, that the grand total of these energy changes of the single electrons describes that of the molecule as a whole. In reality, however, the correlation table shows only that a premoted orbital is higher than the corresponding non-premoted one, but it is unable to indicate, whether both together are higher or lower than the correlated ones in the atom. This correlates a particular orbital, say $1s$, to a particular orbital in the molecule, say $1\sigma\,(1s)$ but we do not know, if the left-hand side of the table, which refers to the molecule, lies as a whole higher or lower than the right-hand side of the separated atoms. To avoid this difficulty, Mulliken fixes the energy relation of the lower ends of the two sides once for all by referring to $H_2{}^+$. Here the potential curve of the single electron can be accurately determined, because only one electron is present. The curve of the non-premoted $1s\sigma\,(1s)$ electron is that of the ground-level of this molecule ion and it is concluded, that it is attractive, *because* the orbital is a non-premoted one. In the neutral molecule H_2 a second electron is present, which finds its place in the same orbital. In He_2, however, the third and fourth electrons populate the next orbital, on account of Pauli's principle, and this, *i.e.*, $2p\sigma\,(1s)$ is a premoted group. Thus the effect of the two first bonding electrons is counterbalanced by that of the two last anti-bonding electrons and therefore chemical combination of two He atoms is not possible.

Here the wavemechanical interaction, which is

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[2] (*a*) H. Lessheim and R. Samuel, *Z. Phys.*, 1933, **184**, 637; 1934, **88**, 276; (*b*) *Phil. Mag.*, 1936, **21**, 41. (*c*) P. C. Mahanti, *Ind. Jour. Phys.*, 1935, **9**, 517.

[3] (*a*) G. Herzberg, *Z. Phys.*, 1929, **57**, 601; H. Lessheim and R. Samuel, *loc. cit.* (*b*) R. K. Asundi, R. Samuel and Mohd. Zaki-Uddin, *Proc. Phys. Soc.* (London), 1935, **47**, 235.

due to the equality of the electrons and is the decisive bonding effect in Heitler and London's calculation, is neglected, because the whole argumentation is solely based on the conditions of H_2^+, where only one electron is present and therefore no interaction with a second electron is possible. *If* linkage generally is due to this interaction, the non-existence of a stable He_2 molecule (formed by unexcited atoms†), will then indicate, that the orbital $1s\sigma$ ($1s$) lies still below $2p\sigma$ ($1s$) but that both the orbitals, the non-premoted one as well as the premoted one, together are higher than in the separated system, *i.e.*, they are anti-bonding, because in the He atom they form closed shells $1s^2$, and the energetical relation of the right and left-hand side of the correlation table in H_2^+ does not permit generalisation. This is corroborated by certain difficulties, which the theory encounters in the case of the molecule LiH, which possesses the same number of electrons as He_2, but exists with an energy of dissociation of 2.5 e.v. It can be shown that there is no other explanation of this rather high energy value possible, but to accept Lennard-Jones' manner of counting by neglecting the closed shells and to consider the valence electron of Li as well as that of H as a $1s$ electron. In this case both of them are bonding electrons but then already one of them should be sufficient for the formation of a stable molecule and the molecules HeH or LiH^+ should exist too. Experimental evidence and wavemechanical calculation show, however, that they do not exist. Furthermore, experimental evidence shows, that H_2^+ is indeed the only example of a molecule with a single valence electron, that not only HeH and LiH^+ but also molecules of the type Li_2^+ or BeH^{2+} do not exist, whereas the corresponding molecules with *two* valence electrons are all well known spectroscopically, *i.e.*, molecules of the type LiH, Li_2, BeH and BeH^+.

In this theory the bonding effect is due not to the interaction of the electrons but to the degeneracy of the nuclear fields. In H_2^+ the fields of the two nuclei are indeed completely identical and Hund has shown, that a single electron possesses bonding power also, when the nuclear fields, short of being identical, are only approximately degenerated. Such a theory of valency considers this effect based on the degeneracy of the fields as the predominating bonding effect, the formation of electron pairs in the molecule being then only incidental. Since this bonding effect is produced by the single electron, the interaction of electrons need not be considered except as a superimposed secondary effect. This conception can be made use of as a wavemechanical interpretation of those chemical theories of valency, which have been developed particularly by Langmuir, Lowry, Sidgwick a.o.,[4] and in which certain types of chemical bonds are brought about by the electrons of one atom only (the "donor") without interaction with electrons of the second atom, and from the original literature it can be seen, that the interpretation of the method of molecular orbitals as a single-electron bond theory of valency has indeed been sponsored by the requirements of the theory of this school of chemical thought.

We have seen that the basic postulate of this interpretation, *i.e.*, the identification of premoted and non-premoted electrons with anti-bonding and bonding electrons has been introduced into the orbital method by fixing the energy relation of the right and left-hand side of the correlation table according to the ground state of H_2^+. In a similar way the postulate of the second possible interpretation of the same method goes back to the neutral molecule H_2. Here the emphasis is laid just on the second bonding effect, produced by the equality of the electrons. Since the electrons are always identical, this degeneracy remains always present and does not require the additional assumption of approximate degeneracy of so vastly different fields as, *e.g.*, C^{2+} and O^{4+} in CO or Be^{2+} and F^{5+} in BeF. So that wavemechanical interaction is brought about and chemical linkage produced by the formation of *electron pairs* in the molecule. Accordingly it is assumed that an attractive $U : r$ curve arises, when electrons of different atoms join in the same molecular orbital, as in the ground state of H_2. The premotion of the electrons plays the rôle of a superposed secondary effect only. Unpremoted orbitals contribute more, premoted orbitals less to the energy of formation, but if a premoted orbital is populated by a pair of electrons, one of either atom, the effect of the interaction may vastly prevail over that of premotion and the total contribution may still be positive. Thus the $^1\Sigma$ term of H_2, which arises when the electrons of the two unexcited atoms enter the premoted orbital $2p\sigma$ ($1s$) is not only stable, but this configuration satisfies also the criterion of linkage of the Slater-Pauling theory, the wavefunctions of the two electrons overlapping. Such a theory leads to the interpretation of the method of molecular orbitals as a pair bond theory of valency and approaches therefore the other wavemechanical methods of Heitler, London, Slater and Pauling. If we compare it with chemical theories of linkage, it may be considered as a wavemechanical interpretation of the pre-wavemechanical pair bond theory of Lewis and its development by Grimm and Sommerfeld.[5]

To our mind recent developments of band spectroscopy have decided more and more against the identification of bonding with non-premoted and anti-bonding with premoted electrons. We mentioned above the spectra of molecules like BeO and BeF, which clearly show that the unexcited metal atoms in the term $s^2\ ^1S$ do not undergo chemical combination. But Be ($s^2\ ^1S$) + O ($s^2p^4\ ^3P$) or + F ($s^2\ p^5\ ^2P$) should form a stable molecule if the above assumption were correct. The premoted and non-premoted σ groups cancel out and there remain four or five p-electrons respectively, all on non-premoted orbitals. As a matter of fact, unexcited Be + unexcited O should form a molecule BeO possessing a triplet term, but experimentally we get a singlet term as the ground level of these molecules. The further assumption, that it originates from Be (^1S) + O (^1D) fails, because the correlation of the molecular term to those of the separated atoms, described above, clearly indicates that

† Indeed a molecule He_2, formed by excited atoms, exists.

[4] *Cf.* N. V. Sidgwick, *The Electronic Theory of Valency*, Oxford, 1927, and contributions to the *Annual Reports of the Chem. Soc. London.*

[5] *Cf.* H. G. Grimm, *Handb. d. Physik*, 1933, XXIV.

the ground-level of BeO involves an excited Be atom and this is corroborated by the spectrum of BeF. This correlation has been used already for about a dozen of molecules of these two types and cannot be taken to be fortuitous. Here clearly exist two electronic configurations, which both should produce stable terms of the molecule according to the single electron bond interpretation of the method of molecular orbitals, but instable terms according to the pair bond theory of valency—and the experiment shows definitely, that these stable terms do not exist. The conclusion, that not the premoted but the odd electron weakens the chemical bond is again at once confirmed by the spectra of all the molecules of NO type, *i.e.*, NO, PO, AsO and SbO.

Furthermore, new spectra are again entirely consonant with this view. Molecules like AlO and GaO behave similar to BeO and MgO. In its unexcited configuration s^2p the metal atom forms only a single link with oxygen and the double bond comes into existence only after the original s^2 group of the metal atom has been broken up. Those excited terms, which possess a higher energy of dissociation than the ground-level on account of the double bond, therefore dissociate into oxygen and an excited metal atom in the configuration sp^2. Again SiF and SnCl behave like BeF, MgF, or NO; they are odd numbered and increase their energy of dissociation by the partial removal of the odd electron, which does not take part in the linkage[6].

If we do not take into consideration hydrides, which approach the " united atom ", but ordinary diatomic molecules, then we must say, that the interpretation of band spectra during the last few years has changed the whole basis for the interpretation of the method of moleculer orbitals as a theory of valency. There is ample experimental proof for the conclusion, that not non-premoted electrons, but electrons, which join in the same orbital with other ones of the second atom confer stability to a molecule and that not premoted electrons disturb the linkage but the unpaired ones. These new results, obtained from new correlations and new spectra are so uniform and follow so closely the predictions of the pair bond theory, that there seems to be little or no doubt for the experimentalist. How far they may serve as the basis of the theory of valency will be seen from a more general survey.

[6] For molecules of the type GaO and SiF, *cf.*, forthcoming papers of R. K. Asundi and R. Samuel, *Proc. Ind. Ac. Sci.* (Bangalore), in press.

(To be Continued.)

Recent Advances in Sanitary Science.

THE following is the extract of an address delivered by Dr. Gilbert J. Fowler, before the Joint Session of the Association of Economic Biologists, Coimbatore, the Indian Academy of Sciences, the Indian Chemical Society (Madras Branch), the Institute of Chemistry of Great Britain and Ireland (Indian Branch), the Society of Biological Chemists, India, and the South Indian Science Association, Bangalore, held at Bangalore on 10th April 1936.

Dr. Fowler dealt with the recent researches on water purification, with particular reference to Madras, the study of sewage-sick soils and the sewage problems of Madras and Ahmedabad. Finally he spoke of recent researches and discussions on the manufacture of compost from waste materials.

Introducing the subject he thanked the President (Dewan Bahadur N. N. Iyengar) for his kind reference to the work which had been done in connection with the provision of compost for the villagers. It was a great encouragement to him that his objective towards which he had devoted a good many years of work seemed now within sight of fulfilment. He referred to a recent address by Sir George Schuster to the Royal Society of Arts in London, where Sir George had quoted Lord Bacon to the effect that money was like muck, it was no good unless it was spread. The scientific utilisation of waste materials for the use of agriculture was a true spreading of wealth. We heard that nowadays in England the distribution by Government of free milk to necessitous school children was an accomplished fact. Such a policy would have been hardly conceivable not so many years ago, yet now it was realised that the safeguarding of the health and well-being of the future generation was the best possible investment a country could make. There was in England at the present time a movement with the object of converting the sewage works of the country into Fertiliser Factories. The economics of this question had awakened vigorous discussion. One school, supported mainly by engineers, was in favour, *e.g.*, of discharging all the sewage of London through a long tunnel into the sea. Another school, representing Biochemistry and Agriculture, was averse even to the water carriage system on account of its waste of fertilising material. In view of the large expenditure of capital on works of sanitation it was of the highest importance that the scientific foundations of the subject should be thoroughly investigated. In his (Dr. Fowler's) opinion, the true solution of the problem would only be found in a close adherence to Nature's cycle. Recent research by McCarrison, Howard and others had shown the immense importance of certain factors which must be present in the food of plants and consequently of animals if the processes of life were to function satisfactorily. It was the little extra something, be it vitamin or hormone, protein cleavage product or whatever it might be named which was characteristic of living process, which determined the health and well-being of the plant and the animal which fed thereon.

Having these considerations in mind, it was interesting to note that the largest modern sewage works, *viz.*, at Mogden (West Middlesex, England) involved a capital cost of approximately £ 1,700,000 which was almost the same as the capital value of the Kolar Gold Fields. The question arose, which was the more valuable, Nitrogen or Gold ?

Recent Researches in the Theory of Meromorphic Functions with Special Reference to the Picard-Borel Theorem.*

Part II.

(Concluded.)

SUPPOSE $f_1(z)$ and $f_2(z)$ be two rational functions which are such that the places at which they take two given values (for simplicity take these to be 0 and ∞) are identical. (The same order of multiplicity.) Then, it is easy to see that they are identical except for a constant. What is the corresponding theorem in the case of two meromorphic functions? The most important theorems in this connection are due to Nevanlinna. His first theorem shows that if for five different a_ν's the equations (1) $f_1(z) = a_\nu$ (2) $f_2(z) = a_\nu$, have identical solutions in z, then the functions are identical. (The functions are meromorphic.) This is proved as follows. Let us introduce the following functions:

$$m_r(f_1, f_2) = \frac{1}{2\pi} \int_0^{2\pi} \log [f_1, f_2]^{-1} \, d\theta.$$

$n(r, f_1 - f_2)$ = the number of zeros of $f_1 = f_2$ in $|z| \leqslant r$. $N(r, f_1 - f_2)$ being defined as before. By the method of proof of the first fundamental theorem it is obvious that

$T(r, f_1) + T(r, f_2) = m_r(f_1, f_2) + N(r, f_1 - f_2)$ $> N(r, f_1 - f_2)$. Let the order of $T(r, f_1)$ be greater than that of $T(r, f_2)$ for definiteness. Then $2T(r, f_1) > N(r, f_1 - f_2)$. Let us denote the functions corresponding to $f_1(z)$ by N, m, etc. Then a little consideration will show that $N(r, f_1 - f_2) \geqslant \Sigma N(r, a_\nu) - \bar{N}(r)$. $\therefore 2T(r, f_1) > \Sigma N(r, a_\nu) - \bar{N}(r)$. But from II, taking $q = 5$, $3T(r, f_1) \leqslant \Sigma N(r, a_\nu) - \bar{N}(r) + 0[\log r T(r)]$. Combining the two we obtain $\underline{\text{Lim}} \dfrac{\log T(r, f_1)}{\log r} < \infty$. $\therefore$ both f_1 and f_2 are rational functions and in that case they are obviously identical. [It is to be noted that we have not at all assumed that f_1 and f_2 take the values a_ν with the same orders of multiplicity. We have merely assumed that they take it at the same places.]

Next we take up the question of the identity of two functions if the distribution for four a_ν's are the same. The results obtained in this case are in a sense incomplete. Nevanlinna has proved that in case the functions take the four values at the same places with the same orders of multiplicity then the functions are identical except in a special case wherein the a_ν's are harmonic and two of them are lacunary values for both the functions; in that case, the two functions are connected by a homographic relation. But no corresponding result in case the restriction about the same order of multiplicity is removed is known. In order to prove these results we have to prove first of all some theorems in connection with meromorphic functions connected by a linear relation and having two lacunary values. This itself is an important chapter in the theory which was started by Borel and developed by Bloch and Nevanlinna; its application to the problems of unicity is due to Polya.

Before proceeding to the proofs of these results we mention a few results which are obvious from the definitions themselves.

(1) $T(r, f) = T\left(r, \frac{1}{f}\right) = T\left(r, \frac{af + b}{cf + d}\right) + 0$ (1).

(2) $T(r, f_1 + f_2) \leqslant 2T(r, f_2) + T(r, f_2) + 0$ (1).

(3) $T(r, f_1 f_2) \leqslant T(r, f_1) + T(r, f_2)$.

Now Picard's theorem can be stated in another form. Suppose an integral function does not take the values 0 and 1; *i.e.*, if $f = e^{g_1}$ $1 - f = e^{g_2}$ where g_1 and g_2 are integral functions, then $e^{g_1} + e^{g_2} = 1$. Picard's theorem asserts that such an equation cannot hold unless when g_1 and g_2 are suitable constants. Borel generalised this result in the following way. Suppose we have a relation of the form $\sum_1^n c_\nu \phi_\nu = 0$ where ϕ_ν's are integral functions which do not take the value zero say. Then, if they are linearly independent, their mutual ratios should be constant. [If they are not linearly independent it should be possible to break up the equation into a number of equations in each of which the functions that occur are linearly independent. The result will be true for each of the new equations.] In order to prove these results we have to deduce the second fundamental theorem in a form deduced by Nevanlinna originally by means of which he deduced II. The theorem is the following:

II'. $m\left(r, \frac{f'}{f}, \infty\right) = 0[\log r T(r)]$ [except for the exceptional intervals. To be always understood].

We give here a new proof by adopting the method of Ahlfors.

Now

$$\lambda(r) = \int_0^{2\pi} \frac{|f'|^2 \rho(f)}{[1 + |f|^2]^2} \, d\theta.$$ Take

$$\log \rho(f) = 2 \log [f, 0]^{-1} \cdot [f, \infty]^{-1} - \beta \log [\log [f, 0]^{-1} \cdot (f, \infty)^{-1}] + C$$

where C is such that the total density is unity, $\beta > 1$, so that the integral is convergent. Substituting the values for $[f, 0]$, etc., and simplifying we have

$$(1) \quad \lambda(r) = K \int_0^{2\pi} \left|\frac{f'}{f}\right|^2 \left[\log \frac{1 + |f|^2}{|f|}\right]^{-\beta} d\theta$$

and

* Abstract of lectures delivered by K. Venkatachaliengar to the Central College Mathematical Society, Bangalore.

(2) $\frac{1}{2\pi}\int_0^{2\pi}\left[\log\frac{1+|f|^2}{|f|}\right]^{-\beta}d\theta$

$$=\frac{1}{2\pi}\int_0^{2\pi}\left[\log\left(|f|+\frac{1}{|f|}\right)\right]^{-\beta}d\theta$$

$\geqslant(\log 2)^{-\beta}$. [K is a constant.]

Utilising this we obtain

$$\frac{\lambda(r)+K(\log 2)^{-\beta}}{2K\pi}\geqslant\frac{1}{2\pi}\int_0^{2\pi}\left[1+\left|\frac{f'}{f}\right|^2\right]\times\left(\log\frac{1+|f|^2}{|f|}\right)^{-\beta}d\theta.$$

Taking logarithms and utilising the fact that the logarithm of the mean is $\geqslant$ the mean of the logarithms we obtain

$$\log\lambda(r)+0(1)\geqslant m\left(r,\frac{f'}{f},\infty\right)-\frac{\beta}{2\pi}\int_0^{2\pi}\log\cdots\cdots$$

$$[\log(f,0)^{-1}(f,\infty)^{-1}]\,d\theta.$$

As $\beta>1>0$, $\geqslant m\left(r,\frac{f'}{f},\infty\right)-\beta\log\cdots\cdot$

$$\frac{1}{2\pi}\int_0^{2\pi}\log[f,0]^{-1}[f,\infty]^{-1}\,d\theta.$$

$$\therefore m\left(r,\frac{f'}{f},\infty\right)\leqslant\log\lambda(r)+0(1)+\beta\log[m(r,0)+m(r,\infty)].$$

As $\log\lambda(r)=0[\log r\,T(r)]$ except in the exceptional intervals we have II″. [$m(r,0)+m(r,\infty)<2T(r)$]. [For the deduction of II from II″ see Nevanlinna's excellent tract.]

We state and derive Borel's theorem in a slightly different way which is seen to be the same after a little reflection. Suppose $\phi_1,\phi_2,\cdots\phi_n$ be any n integral functions which are linearly independent ($\therefore$ their Wronskian is $\not\equiv 0$) and which are connected by the linear relation $\Sigma\phi_\nu=1$. Then, if they have a common lacunary value they are all constants. This is proved as follows. For simplicity let us assume that $n=3$ and the common lacunary value is 0. We have

$-(1-\phi_1)+\phi_2+\phi_3=0$. $\phi_1'+\phi_2'+\phi_3'=0$, and $\phi_1''+\phi_2''+\phi_3''=0$.

$$\therefore\frac{1}{\phi_1}=\begin{vmatrix}1 & 1 & 1\\ \frac{\phi_1'}{\phi_1} & \frac{\phi_2'}{\phi_1'} & \cdots\\ \frac{\phi_1''}{\phi_1} & \cdots & \frac{\phi_3''}{\phi_3}\end{vmatrix}\times\begin{vmatrix}\frac{\phi_2'}{\phi_2} & \frac{\phi_3'}{\phi_3}\\ \cdots & \frac{\phi_3''}{\phi_3'}\end{vmatrix}^{-1}=\frac{D}{\Delta},\text{ say}$$

$\therefore\phi_1=\frac{\Delta}{D}$ [let us use the symbol $T_n(r)$ for $T(r,\phi_n)$].

Let $T(r)$ be of the greatest order among all the characteristic functions that occur. Using the results on the characteristic functions of products and sums of functions, and writing

$$\frac{\phi_2''}{\phi_2}=\frac{\phi_2''}{\phi_2'}\cdot\frac{\phi_2'}{\phi_2},\text{ etc. we obtain by II″}$$

$T_1(r)\leqslant N(r,\phi_1,\infty)+N(r,D,\infty)-N(r,D,0)+0[\log r.T(r)]$.

Now $D=W\phi_1\phi_2\phi_3$, where W is the Wronskian of the ϕ's. Writing the N (r, D)'s in terms of N (r, ϕ)'s and N (r, W) we obtain $T_1(r)=0[\log r.T(r)]$, utilising the hypothesis that the ϕ's do not take the values 0 or ∞. From this it is clear that the ϕ's are polynomia's which contradicts the hypothesis that the ϕ's are not zero. Hence, the ϕ's are constants. [A slight generalisation is possible, *i.e.*, we can assume that ϕ's take 0 and ∞, also. They should only assume them relatively rarely. [N $(r, 0)$ and N (r, ∞) $= 0[\log r.\ T(r)]$.]

Now we apply this result to the theorem on unicity mentioned earlier. f_1 and f_2 are two meromorphic functions which take four given values a_1, a_2, a_3 and a_4 at the same places with the same order of multiplicity. Then, we prove either (1) They are identical or (2) two of these are lacunary values for both f_1 and f_2, the cross-ratio $(a_1\,a_2\,a_3\,a_4)=-1$, and f_1 and f_2 are connected by a homographic relation. Let us assume a_4 to be ∞.

$\left[\text{If it is not so, consider }\frac{1}{f_1-a_4}\text{ and }\frac{1}{f_2-a_4}\right]$.

Then

$$\phi_r=\frac{f_1-a_r}{f_2-a_r},\ r=1,2,3$$

are integral functions with the common lacunary value 0. Eliminating f_1 and f_2 we obtain

$$\Sigma(a_2-a_3)\phi_1+\Sigma(a_2-a_3)\phi_2\phi_3=0.$$

Applying Borel's theorem to the six functions $\phi_1,\ldots,\phi_2\phi_3,\ldots$ all of which exclude the value 0 and dividing them into groups in all possible ways, we obtain one of the following types of alternatives

(1) $\frac{f_1-a_1}{f_2-a_1}=K$ (const.) (2) $\frac{f_1-a_1}{f_2-a_1}=K.\ \frac{f_2-a_2}{f_2-a_1}$

or (3) $\frac{f_1-a_1}{f_2-a_1}=K.\frac{f_2-a_2}{f_1-a_2}$.

If (1) is true then in case the functions are not identical both a_2 and a_3 are lacunary values and as there cannot be more than two lacunary values $a_3-a_1=k\ (a_3-a_1)$ and $a_3-a_1=k(a_2-a_1)$. $\therefore$ $k=1$ or the functions are identical. We can write (2) or (3) as $f_2=S(f_1)$ where S is the homographic transformation; say, $f_2=\frac{af_1+b}{cf_1+d}$.

Then either ∞ is a lacunary value or else $c=0$. The latter case is disposed off as (1). $\therefore$ ∞ is a lacunary value. $\therefore$ S (∞) should also be a lacunary value for both. S (∞) should be one of the three a's or else there would be five values which has already been disposed off. And for the other two a's, S $(a)=a$ obviously. Hence, two of the values are fixed points of the homography and ∞ and the other a are corresponding points. Hence our theorem is completely proved. Nevanlinna has proved that if three functions take three values at the same places with the

same orders of multiplicity then at least two of them should be identical. From our analysis it is also clear that there do exist functions having four identical distributions.

FUNCTIONS MEROMORPHIC IN THE UNIT CIRCLE.

Our preceding analysis confines itself to the distribution of values of a meromorphic function in the neighbourhood of an isolated singularity. A generalisation of that would be the problem of distribution of values of a meromorphic function in the neighbourhood of a line singularity; or in a slightly more general way we consider the problem of distribution of a function given to be meromorphic in a given region (not necessarily simply connected; and the function need not be one valued but should be capable of being continued indefinitely with the exception of only poles as singularities). In such a case we have to uniformitise it; *i.e.*, we shall assume that we have transformed the region to the area of the unit-circle. Then our problem is divided into two. One is the nature of the polymorphic function which transforms the region and the other is that of the distribution of the values of a meromorphic function in the unit-circle. The former does not belong to the subject of the lecture. Therefore we take the latter problem and see how it differs from the earlier case.

The first fundamental theorem is easily seen to be true in this case also; but the fact that $T(r) \to \infty$ as $r \to \infty$ is not obviously true. For all functions which are analytic and bounded in the unit-circle $T(r)$ is certainly bounded. Nevanlinna has proved that if $T(r)$ is bounded then the function is the quotient of two bounded functions. [It is of course not necessarily bounded.] The following is a slightly simplified version of Nevanlinna's proof. $\therefore$ $T(r)$ is bounded $N(r, 0)$ and $N(r, \infty)$ are both bounded. Evaluating the integral $N(r, 0) = \int_0^r \frac{n(r,0)}{r}\,dr$, and $N(r, \infty)$ we easily deduce the following; *i.e.*, if $r_1, r_2, r_3, \ldots\ldots$ be the absolute values of the roots of $f(z) = 0$, in the Unit-circle (multiplicity being taken into account). We obtain $N(1, 0) = \frac{1}{r_1\ r_2\ r_3 \ldots}$, $\therefore$ if $N(r, 0)$ is bounded $\Sigma(1 - r_n)$ is convergent. Let $a_1, a_2, \ldots, a_n, \ldots$ be the sequence of zeros of $f(z)$, $|a_n| = r_n$. Then, we show that the product $f_1(z) = \prod_1^\infty \frac{z-a}{1-z\bar{a}_n}$ converges uniformly in $|z| \leqslant r < 1$. This is easily proved by finding the maximum and minimum values of $\left|\frac{z-a}{1-z\bar{a}}\right|$ in $1 < |a| < r \leqslant z$. We have

$$\frac{|a|+r}{1+r|a|} > \left|\frac{z-a}{1-\bar{a}z}\right| > \frac{|a|-r}{1-r|a|}.$$

From this, it is easy to show that

$$\Sigma\left[1 - \left|\frac{z-a_\nu}{1-z\bar{a}_\nu}\right|\right]$$

converges uniformly in the region considered. From this we deduce that the same is true of the product and $f_1(z)$ is a function which is bounded and analytic in the unit-circle. We similarly form $f_2(z)$ with the poles instead of the zeros of $f(z)$ in the unit-circle. Then it is easily seen $f(x) = e^{\psi(z)}$. f_1/f_2, where $\psi(z)$ is analytic in $|z| \leqslant 1$. Now consider the circle $|z| = r$. Let A_r be the set of points on it for which $R(\psi)$ is non-negative and B_r its complement. Then we determine two functions which are analytic in $|z| < r$, say $\psi_1^{(r)}(z)$ and $\psi_2^{(r)}(z)$ which are such that $R\psi_1^{(r)} = R(\psi)$ on A_r and o on B_r and $R\psi_2^{(r)} = R(\psi)$ on B_r and o on A_r. Then in $|z| < r$. $\psi = \psi_1^{(r)} - \psi_2^{(r)}$. [We assume that a suitable imaginary constant is added.] For a sequence $r_n \to 1$ we determine ψ_1 and ψ_2 similarly. Then as $e^{-\psi_1^{(r)}}$ and $e^{-\psi_2^{(r)}}$ are bounded functions by Vitalis theorem [see *e.g.*, Bieberbach—*Lehrbuch der Funktionen Theorie*, Bd. I] there is a subsequence of (r_n) for which both $\psi_1^{(r)}$ and $\psi_2^{(r)}$ converge in $|z| < 1$ to two functions whose real parts are positive. Let these functions be ψ_1 and ψ_2 respectively. Then we can write $f(z)$ in the form $f(z) = \frac{f_1\ e^{-\psi_2}}{f_2\ e^{-\psi_3}}$. Both the numerator and the denominator are bounded.

We easily see that all other properties which are derived earlier to II are true for this case also; but the theorems on defective values, etc., are not true without some other restriction. We have examples for which $T(r) = 0 \ldots\ldots \ldots\ldots \left[\log \frac{1}{1-r}\right]$ which do exclude any number of values. A Fuchsian function with parabolic substitutions only, *viz.*, the function which transforms a circular polygon whose sides are arcs orthogonal to the unit-circle and which touch each other (on the unit-circle obviously) to the half-plane has the requisite property. [We omit the proof. See Nevanlinna, *loc. cit.*] The next point which needs amendment is the second fundamental theorem. The definition of the exceptional intervals needs amendment. Instead of the exceptional intervals being such that $\Sigma \int_{I_n} \frac{dr}{r}$ is finite (which is obviously meaningless in this case), we should have naturally $\Sigma \int_{I_n} \frac{dr}{1-r}$ is finite. [Note that $\int_0^1 \frac{dr}{1-r}$ is divergent.] With this definition of the exceptional intervals the second fundamental theorem assumes the following form in this case:

$$\overline{\Pi}\,(q-2)\,T(r) \leqslant \sum_1^q N(r, a_\nu) - N_1(r) + 0\,[\log T(r)] + (1+\epsilon)\log\frac{1}{1-r}.$$

(ϵ, any constant > 0) except in the exceptional intervals. We see

therefore that all our theorems, *viz.*, the theorems on defective values, unicity, multiple values, etc., remain the same *provided that* $\underline{\text{Lim}} \frac{T(r)}{\log (1-r)^{-1}} = \infty$. It is already mentioned that in case this is not true the theorems need not be valid. Many of our theorems can be amended suitably if $T(f) = 0\left[\log \frac{1}{1-r}\right]$. We shall state and prove one such result. [See Ahlfors, *loc. cit.*] Suppose $\underline{\text{Lim}} \frac{T(r)}{\log \frac{1}{1-r}} = p$. Then we prove that the total defect is at most $2 + 1/p$. [See Nevanlinna's tract for examples of functions possessing the preceding property.] Dividing II by $T(r)$ we obtain $(q-2) \leqslant q - \Sigma\delta(a_\nu) + \frac{1+\epsilon}{p}$, from which the result is at once apparent.

We close our lecture with one or two slight observations. There is no necessity for exceptional intervals in the case of meromorphic functions of finite order, *viz.*, in case $\frac{T(r)}{r^\rho} < \infty$ for a definite p. Now for all points which do not belong to the exceptional intervals $\lambda(r) < [T(r)]^k . r^{k'}$. Suppose ρ is contained in an exceptional interval (a, b). Now $T'(r) = 0[r^{\rho+1}]$ obviously [as $T(r)$ is a convex increasing function of $\log r$]. And by a slight change we can adjust the exceptional intervals in such a way that $\Sigma' \int_{I_n} r^{\rho+1}\, dr$ is finite. Now take an $r < \rho$, not belonging to any exceptional interval. Then

$$T(r) - T(\rho) = \int_\rho^r T^1(r)\, dr < k \int_\rho^r r^{\rho+1}\, dr.$$

Now we can so adjust r, in such a way that $T(r) - T(\rho) < M$ (independent of ρ). Now $\lambda(r) < [T(r)]^k . [r]^{k_1}$. But $\underline{\text{Lim}} \frac{T(r)}{\log r} = \infty$. $\therefore r^{k'} < [T(r)]^\alpha$ for some α. $\therefore \lambda(r) < [T(r)]^\beta$ for some β.

$$\therefore [\lambda(\rho)]^{\frac{1}{\beta}} < [\lambda(r)]^{\frac{1}{\beta}} < [T(r) - T(\rho)] + T(\rho)$$
$$= T(\rho) + 0(1). \quad \therefore \log \lambda(\rho) = 0\,[\log T(\rho)].$$

We close the lectures with the remark that $T(r, f')$ is of the same order as $T(r, f)$ except in the exceptional intervals. This is too apparent if we put $f' = f.f'/f$ and apply II.

It is to be noted that we have unavoidably omitted many of the other branches of the subject. For a complete study the following books are recommended: (1) Valiron, *Lectures on the Theory of Integral Functions*, (2) Nevanlinna's tract, *loc. cit.* The latter is really a monumental book and also contains the bibliography till the year 1929.

Population Problem and Policy in India.

THE first Indian Population Conference was held at Lucknow on February 3 and 4, under the auspices of the Indian Institute of Population Research. A large number of delegates from the Universities, Provincial Governments and States attended. The Conference was convened by Dr. Radhakamal Mukerjee.

In his address of welcome to the delegates, Dr. R. P. Paranjpye, Vice-Chancellor, Lucknow University, emphasised the importance of the question of population in India in its quantitative, economic and biological aspects as underlying all sound progress. What the country wants, he observed, is a healthy vigorous population, every member of which should have a reasonable chance of living to a healthy old age and contribute to the general happiness of the people. For this, an adequate supply of nutritive food and other conditions of healthy life should be available to all, and the optimum population of a country should be determined by reference to these conditions.

In his inaugural address, the Hon'ble Mr. J. M. Clay, Finance Member, U.P. Government, traced how the pressure of population had been the motive power behind the innumerable migrations and incursions of the human race from prehistoric times. In Europe, we have Italy and Germany claiming the right to expand with their overflowing populations into Africa. In Asia, we find Japan following a similar policy towards China. In India itself, the rapid growth of population presents a problem serious enough to demand the earnest thought of her public men. At the last census of 1931, the population of the sub-continent was 352 millions; it has now increased to at least 370 millions; and unless some retarding factor impedes its natural progress, it will probably exceed 400 millions at the next enumeration in 1941. Indeed, it is not impossible that India may, before the 20th century is much more than half way through, have to support a population equal to that of China. These are staggering figures; they connote problems of the first magnitude for Government and for every thinking man.

Prof. Radhakamal Mukerjee, in the course of his address as convener, discussed at length the problem of India's population capacity. Prof. Mukerjee estimated that India's present food shortage was 48.4 billion calories and the present number of average men estimated without food in India, assuming that others obtained their normal daily ration, was 6.6 millions. India had 162 acres of waste lands which might grow food under an unremitting population pressure, but this could not increase the country's population capacity beyond 441 millions of persons.

Reviewing the growth of population in the country during the last 64 years, Prof. Mukerjee

stated that from 1871 to 1935 it increased from 206 millions to 373 millions and threatened to number 400 millions by the next census year.

By 1931, India's present population capacity was overstepped and just before the end of a quarter of a century, assuming that the present rate of increase continued, India would overstep 441 millions—the ultimate population capacity under the existing farming and living standards and industrial conditions of the people.

Recent movement of prices, especially of agricultural produce, had compelled, and would compel more and more of even the well-to-do peasants, to reduce their standard of living.

Modern education, medicine and public hygiene have reached the Indian village, and, as these spread more, birth-control will shock people less and an "adaptive fertility" will relieve the present heavy population pressure.

It is only when the fertility of India's work-a-day millions becomes somehow adapted to the present situation of definite and increasing food shortage, through their forethought and new attitude in the matter of the family, that India can look for a fresh advance of improved agriculture, education and mass sanitation in her villages. These will be followed up as in the West by a reduction of mortality and increase of average longevity, and thus, as more and more of human fertility is left to lie fallow, there will be an enrichment of life, its equipment and experience from all sides.

VITAL STATISTICS SECTION.

In his presidential address before the Vital Statistics Section of the Conference, Prof. K. B. Madhava of Mysore University pointed out the defects and absence of registration of various aspects of demography, such as birth and death, sickness, marriage, fertility, dependency, etc., and advocated that small areas may be selected and the registration of statistics may be arranged in these by the labour department, by municipalities or universities. Without adequate data we cannot get correct pictures of society and the changing conditions in these. Anthropometric measurements might also be undertaken by medical colleges and public health programmes might be formulated in lines with their findings. Insurance companies in India may, as in some countries of the West, carry on researches into disease and co-operate with public health agencies.

In an important paper on the forecasting of population growth in India, Prof. K. K. E. Raja estimated that unless some untoward event, such as a large-scale famine or epidemic, occurred, the population of British India will be likely to approximate 400 millions in 1941. The favourable age composition of the married female population in India and the increase of their reproductive period, the decline of the death-rate, and other biological factors indicate that we are fast moving towards the 400 millions.

A paper by Mr. Murli Dhar Joshi of Allahabad University showed cyclical variations of birth and death-rates indicating periods of 3.6, 5.6 and 11 years.

Dr. Radhakamal Mukerjee added that this entirely agreed with his findings of a correspondence of droughts and famines in Northern India with sun-spot occurrence which therefore initiated in some measure rainfall, vital and economic cycles in India.

Dr. Cristopher Tietze, a physician of Vienna, submitted a paper which showed the inaccuracy of registration of births and deaths and the resulting under-estimate of birth-rate and death-rate by a large margin.

Dr. H. D. Mathur showed by means of some interesting diagrams the relation between overcrowding and chronic house shortage in Lucknow with tuberculosis and respiratory diseases.

Prof. Adarker's paper on the trend of population elicited a lively discussion towards the conclusion of this session.

DIET AND NUTRITION SECTION.

The dangers to the rice-consuming people of India from eating polished and parboiled rice were stressed by Dr. Nilratan Dhar, speaking on "Food and National Efficiency" in his presidential address before the Diet and Nutrition Section of the Indian Population Conference. He emphasised the need of State intervention in this matter and urged for the rationalisation of agriculture to ensure the supply of food for the poor being upto the standards required for health.

Dr. Radhakamal Mukerjee in a paper stressed that industrial workers in India were accustomed to more varied and more adequate dietary in the cities than the peasants in the villages. On the other hand, the calories at which the Indian working man's dietetic position ordinarily stood were much less than the British dietary level. This was responsible not only for lower weight, less stamina and more apathy, but also for the less strenuous work which could be done.

The results, he added, of investigations of the specific effects of nitrogenous foods on hard work might contribute materially to the increase of industrial efficiency. The co-operation of physiologists, psychologists and economists was essential in order to analyse and control all the factors which govern both the speed and volume of production in the country.

Dr. W. Burridge, discussing the calorie requirements in India, stressed the differences due to climatic factors. No workman can work without enough nourishment. Over the greater part of the year, however, manual work in India is done in great heat, and to do work in relative comfort under such circumstances the build of body required is the build which he possesses. There is no evidence that the Indian labourer was ever better off than he is to-day. He is just a man with thousands of years of adaptation behind him.

ECONOMICS SECTION.

Presiding over the Economics Section, Dr. Radhakamal Mukerjee spoke on "Food Standards and Agricultural Practices" and stressed the needs of analysing food consumption and food values in India which was quite inadequate. There was also, he regretted, lack of precise information relating to weights of individuals taken in the fields, factories and workshops per individual.

On the basis of investigations of the basal metabolism, he proposed the following standards of calorie requirements in India: for Bengal and Southern India (rice and legume-eaters) 2,000 calories (proteins 50, fats 50 and carbohydrates 475 grammes) and for Northern India (wheat and legume-eaters) 2,400 calories (proteins 60, fats 60 and carbohydrates 475 grammes).

Throughout India, he proceeded, the food materials were determined by what the fields yielded under different conditions of climates and soil and irrigation as well as under heavy population pressure. In fact, the physical characteristics of the Indian peoples, their dietary and cropping were all governed by regional conditions.

A heavy burden of population causes a large and even wholesale substitution of wheat by barley and the cheaper millets as foods and a complete omission of animal products, fruits and vegetables. This causes unbalance in diets which is particularly characteristic of the poorer sections and communities in India. On the other hand, agricultural progress is measured by the use of the more esteemed cereals such as wheat and rice and absolute increase in cereal consumption. However greater may be the food value of animal products, the consumption of these cannot be easily increased as that of soya-beans, peas, etc., which may form a valuable addition to the dietary of the Indian cultivator under the existing farming organisation, adjusted as it is to a heavy population pressure.

Diseases due to mal-nutrition are quite well known in India. Apart from diarrhœa, dysentery, beri-beri, epidemic dropsy, etc., the higher incidence of leprosy in the South, West and East of India has probably a nutritional basis. The increase of leprosy in the rice tracts of Northern Orissa, South-Western Bengal, Deccan and Madras is perhaps connected with the exhaustion of soil and deficiency of food values of rice grains. With an increase of population pressure on the soil, deforestation has gone on for decades and this has also contributed in no small measure towards the lowering of housing conditions in villages by making the supply of timber and bamboo scarcer and scarcer.

Such is the low standard of living that family budgets of peasants and industrial workers, collected from different parts of India, do not show the expected increase of percentage in expenditure on clothing, bedding and utensils with an increase in income. Mal-nutrition, illiteracy, sickness and high mortality all create a vicious circle, while slow industrialisation and absence of opportunities for emigration make an escape impossible.

Mr. D. P. Mukerji discussed the logical validity of the concept of Optimum as representing a standard towards which present economic conditions are ideally related.

Mr. B. N. Ganguly of Delhi University, pointed out that in an area of congested population, there is a great need of agricultural planning and of a balanced development of industry and agriculture based both on food and commercial cropping.

In a paper based on intensive investigation on the cost of living of the industrial labourers of the U. P., Mr. S. P. Saksena found that the average quantity consumed was less than the jail diet by at least 1 *chattack*, and that it was also inferior in quality.

Sociological Section.

Professor Benoy Kumar Sarkar, in his presidential address to the Sociological Section of the Conference, pointed out that India's output in the sciences of sociology and population as developed in modern times was very modest. In neither field was it possible for anybody to make a debut to-day on the foundation of settled facts and universally accepted generalisations. The situation was on the contrary rather that of powerful controversies. One might speak of a virtual crisis in both these disciplines. Never was the necessity for avoiding any unstinted and unthinking alliance with one or other of the warring schools of systems of sociology and demographic thought more profound than to-day. At the threshold of the first Indian Population Conference, which happened also to be the first Indian Sociological Conference, it should be reasonable, he said, to maintain a thoroughly objective and critical attitude in regard to the prevailing "isms" and policies. In conclusion he put forward a strong plea for rationalisation of demographic distribution.

Speaking on the Dysgenic Trends of the Indian Population, Dr. Radhakamal Mukerjee stressed that, in India, for several decades, the intellectual social groups on account of such dysgenic customs like rigid hypergamy and endogamy as well as of a natural paucity of females, are showing either smaller natural increases or actual diminutions, as in the United Provinces. On the other hand, the less literate and backward social groups are more progressive demologically and these threaten to swamp the cultured stocks, especially in the prosperous areas in the Ganges plain. As in the West, the most fertile social strata in India are inferior but nowhere is the disparity between fecundity and culture greater than in Northern India.

Family Hygiene and Eugenics.

Problems of Marriage and Birth-Control were discussed before the Section on Family Hygiene and Eugenics. Dr. Khanolkar, in his presidential address, spoke on the biological evolution of marriage and the light it throws on contemporary Hindu marital life. He discussed particularly the inhibitions, which are such outstanding characteristics of the Hindu marriage, now being looked upon as tyrannies, as an investigation regarding the views on marriage of contemporary Hindu youths has indicated in Bombay. The new spirit of individualism will act on the mass of old ideas. It is the duty of scholars as well as leaders of social thought to give their serious consideration to the problem of marital adjustment in order that the features of an ancient institution, that do not fit in with the new social outlook may be reconciled with the essential demands of stable marital relationship.

Prof. G. H. Ghurye read an interesting paper giving the results of his enquiry regarding 3,400 marriages amongst the Brahmin community from Kathiawar. He drew attention to the fact, by means of statistical analysis, that only about 12 per cent. of the marriages studied were completed families, *i.e.*, families in which the husband and the wife lived till the wife attained her 45th year. On an average, the duration of the marriages, that were broken as a result of the death of one of the partners, was five years longer than the average duration of the continuing marriages. The average fertility of a complete family was found to be a little over six, while the number of children surviving till the break of marriages per broken marriage was not even three. It was seen that of the males, who lost their

first wives, more than 70 per cent. did not re-marry and that those who re-married were generally young and had no children. The conclusion was clear that Hindu males did not re-marry light-heartedly.

In an interesting paper on marital adjustment in the changing social order, Dr. N. N. Sen Gupta emphasised that a programme of marriage reform must be based on a reconciliation of the ideal of romanticism, which is easily apt to mingle with a bare physical desire and the ideal of marriage as a sacrament. No doubt the practice of birth-control, which has come in vogue among the middle and richer classes of the society, prevents strain on the family income and the health of the mothers, but it also has encouraged casual sexual intercourse unmitigated by durable love or high ideal as well as an experimental attitude towards the partner.

This was followed by an interesting discussion on birth-control in which it was stressed by Dr. Radhakamal Mukerjee that, while the practice of birth-control is associated with the risks of an easy romanticism and loose sex life, which may themselves prevent the maturation of the sex sentiment representing, as it does, not an isolated drive but a wide variety of blended attitudes and interests, it is calculated, on the other hand, to re-integrate the diverse impulses which bind the partners when poverty, economic strain or the health of the mother threaten to sunder them. Thus birth-control may contribute towards both marital stability and unstability, according to the attitude, education and culture of the partners.

ANTHROPOLOGICAL SECTION.

In a comparative survey of the vital and economic conditions of the primitive races in India, in his presidential address before the Anthropological Section of the Indian Population Conference, Dr. Panchanan Mitter of the Calcutta University showed the dangers arising from the primitives being taught by missionaries and others to despise themselves and their own religion and tribal system while their economic transformation had not been commensurate to meet their newly acquired needs.

He pleaded for the following "safeguards" when the primitives under the new constitution would be dissociated and taken out from the midst of a system in which they have survived: (1) A competent anthropologist should be in charge of the primitive areas. Missionary zeal should be carefully watched and kept under control. (2) The economic cycle of the primitive area should also be carefully observed and economic development fostered and guided in keeping with this cycle. (3) The tribes should be protected against the unscrupulous money-lender and the landlord by special legislation, while the socio-economic relations between them and the surrounding civilised people should be regulated to promote assimilation in gradual stages of the tribal system to the politico-economic system of the rest of India.

Dr. D. N. Mazumdar, of Lucknow University, mentioned cases of a large number of tribes who were dying out. The *Korwas*, for instance, were becoming extinct like the Andamanese. Similarly, the Gonds and Bhils had enormously declined. Among the causes of decline or extinction of primitive tribes, Dr. Mazumdar mentioned the operation of stringent forest laws, the decline of charcoal-making and the administration of inappropriate excise laws and regulations.

In his concluding address before the Indian Population Conference, Prof. Radhakamal Mukerjee stressed the urgent need of a sane population policy in India. The population problem was not one of mere food supply—for a programme of removal of illiteracy and of sanitation was deferred or baffled, because population outran the capacity of education and sanitation.

On the other hand, proceeded Prof. Mukerjee, mere increase of production could not solve the problem now inherent in the situation, such as too low a standard of living, too high a proportionate cost of labour and crop yields which should be increased. Unless some check was placed on population growth, any other remedy tended to be only temporary; for, population would rapidly rise again to the maximum number of persons the land could support.

Prof. Mukerjee held that the days of large-scale irrigation projects, expanding cultivated areas, were also over in India. Industries, again, had progressed at a slow pace, while planned colonisation and inter-provincial migration had drawn little attention. He, therefore, emphasised the need of systematic crop and food planning, which should be undertaken by Government. India's minimal requirements for the congested population would, he thought, be covered by an increase of the production of peas, grams, pulses and oil-seeds, which would no doubt expand in substitution of grain. It was in this direction that India's subsistence farming could be adapted, as in China and Japan, to meet her chronic food deficiency and distribute the labour of the peasant family to better advantage throughout the year. Without a judicious combination of food and money crops and a balanced economy of agriculture and industries, population pressure would continually tend to produce a chronic mal-nutrition and lower the standard of living of the masses.

It was a strange paradox in India that, as the social scale was descended, the fertility increased but the survival value diminished. The survival value of the agricultural castes was exceedingly low in India and poverty, illiteracy and low survival value went together.

"The problems of Indian population," concluded Prof. Mukerjee, "are thus not merely economic. These are problems also for social reform, education, sanitation, eugenic and even of religion. Economics, ethics, religion and scientific humanitarianism all should co-operate in solving the various problems of over-population and mis-population in the country."

The work of the Indian Institute of Population Research, whose headquarters will be at Lucknow, has been divided among a number of standing committees working in various centres, namely, on population biology at the Bombay University under Dr. Ghurye, population hygiene under Prof. Raja at the Calcutta School of Tropical Hygiene, anthropological problems under Dr. Panchanan Mitter at the Calcutta University, population statistics under Prof. Mahalanobis at the Indian Statistical Institute and population economics under Dr. Radhakamal Mukerjee at the Lucknow University.

The next session of the Population Conference would be held in Bombay after two years.

Science Notes.

A Prehistoric Iron Implement from Malacca.—At the ordinary meeting of the *Asiatic Society of Bengal*, held on 6th April, Mr. Johan van Manen exhibited an iron implement, sent by Dr. P. V. van Stein Callenfels, the Dutch archæologist, who wrote, "from time to time a peculiar iron implement is found in the Peninsula of Malacca concerning which no one knows the use or manner of application. The Malays call it *Tulang mawas* which means 'bone of orang-utan'. They say that in olden times there lived large apes with iron bones and an iron spur at the elbow, and that this is what constitutes the implement.

"In connection with the find spots, I have always supposed that it may have been an old type of miner's instrument used by early tin miners. It is not, however, clear to me how that should have been.

"A short time ago, whilst investigating a few so-called 'slab graves', graves built up out of stone slabs, which are an offshoot of the megalithic culture occurring in the Malay Peninsula, in Southern Sumatra and in Java, we found an appreciable collection of such instruments which make it clear that they are connected with the slab grave builders, and have been probably introduced by them.

"These slab graves are found along the rivers running into the Strait of Malacca and are therefore evidently relics of immigrants who moved inland along these rivers, perhaps searching for tin. In my opinion, the mining hypothesis is therefore not without foundation. I believe to discern a certain Indian influence exercised at the end of the pleistocene, upon this part of Further Asia, but after this all Indian influence ceases and everything is here derived from south-west China, *via* Siam.

"These slab graves, which I feel inclined to date about the beginning of the Christian era, bring us for the first time again the Indian influence which soon expands widely and leads to Hinduisation of Sumatra, Bali, Indo-China, and so on.

"If this be the case, the iron instrument must have an Indian origin and there may be a possibility that India may bring a solution of the questions as to for what purpose and how it was used."

Other exhibits shown and commented upon at the meeting are: (1) Three small brass images from the Chittagong District—Dr. Ramaprasad Chanda. (2) Kharidat al-Qaṣr—M. Hidayat Hosain.

Dr. N. C. Sen Gupta gave a paper on "Putrikaputra or the appointed daughter's son in ancient law."

Mr. Everett H. Rankin and Mr. John Campbell White were ballotted for as ordinary members of the Society.

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Indian Chemical Society.—At the ordinary meeting of the Society, held on the 24th March at Calcutta, Dr. B. C. Guha delivered a lecture on Vitamin C. Rev. Father J. van Neste, S.J., presided.

The following gentlemen were admitted and elected as Fellows:—

Admitted.—Mr. G. Narayan (Bangalore); Dr. Chittaranjan Barat (Calcutta); and Mr. Birendra Nath Maitra (Calcutta).

Elected.—Mr. Dilip Kumar Banerji (Calcutta); Mr. Santi Ranjan Palit (Calcutta); Mr. Dhirendra Mohan Mukherjee (Barisal); Mr. Kanai Lal Roy (Calcutta); Mr. K. S. Venkat Raman (Benares); Mr. Dhirendra Nath Majumdar (Benares); Dr. Surendra Nath Ray (Calcutta); Mr. Jagannath Gupta (Calcutta); Mr. Sachindranath Datta (Gwalior); Mr. G. P. Pendse (Gwalior); Mr. K. V. Giri (Bangalore); Prof. S. D. Arora (Jodhpur); Dr. Umaprasanna Basu (Calcutta); and Prof. S. N. Bose (Dacca).

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Institution of Chemists (India).—The annual meeting of the Institution was held at the University College of Science, Calcutta, on the 29th February. The annual report which we have received gives an account of the activities during the year 1935. The Institution lost two members (Mr. H. Cooper, Ph.C., F.C.S. and Mr. J. N. Sinha, B.Sc., M.Sc., A.I.C.) by death, and one member by resignation; thirteen new members were elected. Seven ordinary meetings were held for reading and discussion of papers which have all been published in the *Proceedings of the Institution* (Quarterly).

In the course of his Presidential Address, Prof. H. K. Sen dealt with some aspects of industrial research and industrial development. After discussing certain vital questions, such as industrial co-ordination, standard of living, survey of natural resources, etc., he proposed that under the auspices of the Institution a "machinery composed of representatives, financiers, experts, engineers and such others to study and organise methods of industrial development, be created without loss of time, as the first instalment towards the solution of the unemployment problem. This body with the advantage of its experience, should be able to give a unique impetus to India's industrial regeneration. I make bold to propose, further, that our Institution should take upon itself the task of a bureau of industrial information and be in active co-operation with bodies, private or government, with similar aims. In fact, such a new orientation of our activities would constitute a distinct step in the right direction." Prof. Sen indicated an immediate solution of the unemployment problem of the educated classes. He said, "if a group of villages, five, ten or twenty, according to population and produce, would take it into its head to employ half a dozen educated young men to look after its sanitation, education, drinking water, milk and other food products, road-making, mosquito-killing, etc., out of no other sense than to increase its efficiency, I have no doubt the present unemployment would disappear in no time."

The following members have been elected to the Council:—*President*: Dr. H. K. Sen, M.A. D.Sc., D.I.C.; *Vice-Presidents*: Mr. N. Brodie, Dr. E. Spencer, Dr. T. S. Wheeler, Mr. N. N. Sen Gupta, Rao Sahib M. N. Ghose, Mr. J. R. H. Bartlett; *Hon. Secretaries*: Mr. S. N. Sinha and Dr. M. N. Goswami; *Treasurer*: Mr. K. B. Sen; *Members*: Mr. J. K. Adhya, Mr. T. S. T. Chari, Mr. D. S. Naidu, Dr. S. G. Chowdhuri, Mr. Ronald

Alcock, Mr. Satya Prosanna Sen, Dr. Haridas Sen, Mr. P. K. Das Gupta.

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Indian Institute of International Affairs.—For the purpose of scientific study of international affairs, an organisation called the Indian Institute of International Affairs was inaugurated by H. E. Lord Willingdon on March 3rd. This is the Indian branch of the Royal Institute in London, which was started 16 years ago. The parent body has a valuable collection of books, and collects, examines and distributes international information. Commander Stephen King Hall, Official Representative of the Royal Institute, came to India to assist in the formation of the Indian branch. The Institute is strictly non-political in character.

In the course of his speech, H. E. The Viceroy said, "The growing interest of India in international quarters is the justification for the step that we are now about to take. Accurate information is most necessary on various issues which now dominate the international situation and by which India is affected, and this is one of the services which the proposed Institute will provide."

H. E. The Viceroy of India is the Hon. President of the Institute.

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The Madras Science Club.—The first annual report of this interesting institution, recently started in Madras, states, that it owes its existence to the initiative of Mr. K. S. Varadachar, who, it should be acknowledged, was actively associated with the foundation of *Current Science*. The Club was founded mainly to promote social amenities among the scientific workers in Madras and the report records a session of useful work. Prominent scientists in Madras are associated with the Club which, we hope, will continue to fulfil the purpose, for which it has been organised, in an increasing measure.

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The Roerich Central Asiatic Expedition for Drought-Resisting Plants.—The United States Department of Agriculture has sent an expedition to scour Central Asia in search of drought-resisting pasture grasses, for use in reclaiming drought-made desert land in the United States. On the edge of the Gobi desert in Central Asia, are great pasture lands where the summer temperatures often go above 100° and the winter temperature more than 40° below zero. The rainfall in the area is less than 16 inches annually, but apparently there are certain pasture grasses which, through thousands of years of natural selection, have adopted themselves to severe environmental conditions. Besides drought-resisting pasture grasses, the explorers hope to discover grasses and shrubs with root stocks of a type suitable for preventing arid and water erosion in dry land areas.

Prof. Nicholas de Roerich, the eminent Russian Archæologist, painter and leader of culture, is in charge of the expedition to the Hingan Mountains and the plains adjoining the Gobi. Prof. Roerich is a recognised authority on Central Asia, having made expeditions into Sikkim, Kashmir, Tibet, Chinese Turkestan, Mongolia, the Gobi Desert and the Altai Mountains. He is ably assisted by his son, Dr. Georges de Roerich, who possesses expert knowledge of the Central Asiatic tongues.

Numerous species suitable for transplantation in America have already been collected. More than 350 lots of seeds have been despatched to the United States Department of Agriculture for trial; while in Mongolia, a number of samples of soil have also been collected and despatched. According to a report appearing in the *Penang Gazette* (8th Oct. 1935), Prof. Roerich alluded to a recent project to re-afforest the mid-western plains of America, or as an alternative to plant a thick belt of trees running in a straight line north and south, so as to keep the fertile plains of the east, free from sand blowing over from the west.

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Expedition to Japan to Observe the Total Solar Eclipse.—The Government of India have sanctioned the deputation of Dr. Royds, Director of the Kodaikanal Observatory, to Japan to observe the total eclipse of the sun on June 19th, 1936. Dr. Royds is taking with him from Kodaikanal what is probably the most powerful spectrograph ever used at an eclipse. In Japan he will join up with the expedition under Prof. F. J. M. Stratton organised by the Royal Society and the Royal Astronomical Society.

The totally eclipsed sun exhibits certain appendages, which cannot be seen at any other time, and these afford clues to the constitution not only of the sun but also of those stars which are known to resemble the sun. Two different atmospheres of the sun become visible to the naked eye, viz., the olive green corona with its streamers and the rosy red chromosphere with its prominences, while with special instruments a still lower atmosphere can be studied.

The Kodaikanal Observatory Expedition is especially to study how the wavelength in different parts of the sun's disc is affected by the scattered light from other parts of the disc. Another problem with which the expedition is concerned is the more exact determination of the wavelengths of the chromospheric lines: it is hoped to reach an exactness never before achieved. The expedition is also interested in the appearance of the oxygen lines in an eclipse, since the successful observations of these lines without an eclipse has recently been made at the Kodaikanal Observatory (*cf.* Communication by Drs. A. L. Narayan and T. Royds, published under *Letters to the Editor* section in this number).

About a ton of instruments will be carried. Mr. Marsden, a science teacher in a Missionary College at Nagercoil, is making his own way to Japan, primarily for sight-seeing, and will help the expedition in the management of the arc-lamp.

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Drug Control in India.—Mr. B. D. Amin, Managing Agent and Director, The Alembic Chemical Works Co., Ltd., Bombay and Baroda, has recently issued a pamphlet which draws pointed attention to the urgency of enacting a Drug and Pharmacy Act, not only for protecting public health, but also for safeguarding the indigenous pharmaceutical industry. In an editorial note appearing in a recent number of this *Journal* (*Current Science*, 1935, **4**, 368–369) we have referred to the menace of drug adulteration and of traffic in spurious drugs. The proposals made by the Drug Enquiry Committee are admittedly adequate, but so far no effective legislation appears to exist for bringing about

a uniformity of control throughout India. Lt.-Col. R. N. Chopra's learned contribution on "Drug Adulteration and Spurious Drugs in India", which has been reproduced from the *Calcutta Medical Journal* and appended to the pamphlet, covers in a short compass, the salient points of the question and makes an eloquent plea for the enactment of adequate legislative measures.

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Problems of the Jute Industry.—Far-reaching recommendations for the development of the Jute Industry are contained in a report by Dr. S. G. Barker, who recently came to India to examine the scientific and technical development of the Jute Industry on behalf of the Indian Jute Mills Association. A comprehensive research scheme, estimated between £ 25,000 and £ 30,000 a year, has been proposed for research, covering experimental work, intelligence service and the provision of an information department. According to Dr. Barker, these activities must be entirely controlled by the industry and be an integral part of its structure. The complete autonomy of the Indian Jute Mills Association in this matter is essential. The Central Laboratories should be situated as near as possible to Calcutta, as most of the research will have to be developed under mill conditions. Dr. Barker's plan is designed to maintain the present market, recapture lost markets and gain new ones. According to an account appearing in *Statesman* (March 3, 1936), the report points out that "competitive materials have adopted scientific methods of cultivation, extraction and control in manufacture. The advance of science in other industries, both competitive and consuming, will accentuate the jute-marketing problem. The competitive commodities by their scientific origin are capable of modification to suit specific uses. Jute must also be able to do this by the establishment of an organisation to study ways and means of conferring upon either fibre or fabric characteristics which they do not possess in the ordinary natural condition." The function of science, therefore, will be to permeate throughout the jute industry a new and additional vista of its technique and scope, thus extending its uses and augmenting its rates of production per man-power. The report comprises a masterly survey of the problem and sets out a scheme of research commensurate with the needs of a growing industry.

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A tiny wanderer of the sky, which might be considered either a comet or a minor planet, has been re-sighted by telescopes (*Science*, Feb. 21, 1936, *Supp.*, 6). It is the Delporte object first seen in 1932. It has the distinction of making the second closest approach to the earth of any such comet or planet. Its magnitude is 13, according to the Harvard College Observatory reports, which means that it is possible to see it only with large telescopes. It is located somewhat west of the constellation of *Leo*. The Delporte object is also known by the name of *Amor* and its number among the minor planets is 1221.

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New Magnetic Alloy.—Research on the part of Canadian General Electric has resulted in a new, very powerful, permanent magnet alloy which will enable small motors and various control devices to use permanent magnet fields at a much lower cost and with greater simplicity of design (*Canadian Chemistry and Metallurgy*, Feb. 1936, **50**). The new alloy, which is named *Alnico*, is usually a cast material finished to shape by grinding and was first developed to resist scalding and deterioration at high temperatures. A heat-treating process has now been perfected by which its magnetic qualities are fully developed.

Only a few years ago an alloy of iron, aluminium and nickel was found to possess suitable permanent magnetic qualities. This alloy contains no carbon and belongs to the precipitation-hardening class alloys, quite distinct from the steel. The addition of cobalt was the step that produced the new *Alnico*, which has a specific gravity of 6.9, and is non-corrosive but brittle. It is said to have a higher coercive force and a lower residual induction than any other. The maximum available energy is higher and occurs at a lower flux density and a higher demagnetising force. Magnets of the alloy therefore require a higher force to completely magnetise them, and are less subject to demagnetisation by stray fields, high temperatures and mechanical vibration.

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A New Skin Germicide.—It is reported (*J. Soc. of Dyers and Colourists*, Feb. 1936, **61**) that a new skin disinfectant, possessing 350 times the power of alcohol and thrice that of tincture of iodine, has been introduced in the United States. It is stated that the product contains 50% of ethyl alcohol, and varying amounts of acetone, mercuric chloride, hydrochloric acid, chrysoidine Y, and distilled water. The dye used, besides having antiseptic properties, is said to fade out in 24 hours. The alcohol assists in the penetration of the mercuric chloride, the acetone removes fat from the skin, and the acid increases the germicidal activity of the mercuric salt.

* * *

New Provinces in India.—The inauguration on the 1st April of two new Governor's Provinces, Orissa in the south-east and Sind in the north-west, marks an event of momentous significance to India. The two Provinces make well-defined linguistic areas and are clearly geographical units. The Nehru Report gave prominence to the desirability of amalgamating the Oriya-speaking tracts of Madras, Central Provinces, Bihar and Bengal into a separate province under a Governor, as this unification will be conducive to the cultural and industrial development of the Oriyas. The geographical isolation of Sind from Bombay, the linguistic differences between the inhabitants of Sind and of Bombay and the persistence with which the Sindhis urged for a separate province, make out a clear case for the separation of Sind from Bombay. Sir John Hubback and Sir Lancelot Graham have the unique distinction of being the first Governors of Orissa and Sind respectively.

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It is understood that the Government of India have under consideration the question of establishment of additional seismological laboratories in the country.

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The Imperial Council of Agricultural Research has constituted two Standing Committees on Rice and Wheat which will consider all matters

pertaining to "the production, marketing and general improvement of the two crops".

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Lt.-Col. G. Covell will officiate as Director of Malaria Survey, India, *vice* Lt.-Col. J. A. Sinton, granted eight months' leave.

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Mr. L. M. Statham has been appointed Director of Public Instruction, Madras, in the place of Mr. H. F. Saunders, proceeding on leave.

* * *

Sir C. V. Raman, Kt., F.R.S., N.L., has been elected Honorary Member of the Royal Irish Academy in the Department of Science.

* * *

Khan Bahadur Mian M. Afzal Hussain, Principal, Punjab Agricultural College, Lyallpur, and Entomologist to the Punjab Government, is representing India at the International Locust Conference which is being held at Cairo this month. The Khan Bahadur intends to tour in Europe after the Conference to visit the various agricultural colleges and research institutes.

* * *

Mr. Har Dayal Srivastava, M.Sc., Helminthologist, Imperial Institute of Veterinary Research, Muktesar (Kumaun), was elected an Ordinary Member of the National Academy of Sciences, India.

* * *

Spolia Zeylanica (*Ceylon Journal of Science.*)—Part 3, Vol. 19 of the *Ceylon Journal of Science*, contains, besides other articles, a series of interesting papers on some fishes, reptiles and mammals of Ceylon. Mr. Deraniyagala has contributed papers on fishes from Ceylon, the post-natal changes in the leathery turtle, Dermochelys, comparative study of Caretta and on a new crocodile. Affinities of Lorisoids and a survey of the distribution of mammals are contributed by Osman Hill and W. W. A. Phillips, respectively. With regard to the new crocodile, Deraniyagala notes that according to Boulenger, the Indian crocodile has the dorsal scutes arranged in four longitudinal series, the median ones being the biggest. In the Ceylon form, six longitudinal rows are present and the scutes are sub-equal. Moreover, the Ceylonese form is noticed to infest fresh-water while the Indian ones is "usually, if not always, above the limits of salt water". The extra peninsular form is named *Crocodilus palustris kimbula*, sub. sp. nov.

Osman Hill, in dealing with the affinities of the Lorisoids, reviews briefly the anatomical characters of all the systems of the Indian slender Loris and compares them with those of Lemur, an inhabitant of Madagascar. He concludes after a careful discussion that the Lorisoids are more closely allied to Tarsioids. The common characters, however, between Loris and Lemurs, are probably due to the retention of primitive mammalian features or to a parallel evolution. Following this line of thought, Hill introduces a new classification where the Haplorhine suborders, Anthropoidea, Pithecoidea and Tarsioidea are treated as equal to the sub-orders of Strepsirhiæ, *viz.*, Lorisoidea, Lemuroidea, Chiromioidea and Cæciliolemuroidea.

* * *

Spectrographic Outfits for Metallurgical and General Chemical Analyses.—Seventh edition. January 1936. Adam Hilger, Ltd., 98 King's Road, London, N. W. 1. 60 pages. Illustrated. Post free.

This catalogue describes a new range of models of the well-known Hilger Quartz Spectrographs. These include the three instruments which are known all over the world as the small, medium and large models. All of them have been redesigned and take the Hilger Accessory Bar for the correct alignment of accessories. The large instrument is now offered in a fully automatic model, which is of great advantage in the industrial control of metals and alloys. A new size spectrograph has been introduced, intermediate in size between the small and medium, and therefore known as the Intermediate. An exceptionally complete range of accessories is described for both qualitative and quantitative analysis, including outfits for the Stepped Sector and the Lundegardh Flame methods.

Sound advice is given on the choice of apparatus for specific applications.

The six pages of names of users of Hilger Spectrographs are an interesting indication of the widespread use of spectro-analytical methods.

* * *

New Jena Glassware.—Laboratory workers and admirers of Jena glassware will be glad to learn that a new Jena glassware has been introduced under the title "*Duran Glass*" which combines the chemical characteristics of the Jena glassware with the resistance properties generally associated with Pyrex and similar class. The physical properties are :—

> Coeff. of expansion, 3.6×10^{-6}; annealing temperature, 539° C.; Tenacity per gramme, 774° C. whilst the chemical properties are summarised by—loss of weight in mg. per decimetre square is 0.008 in water in 3 hours, 0.37 in 20% HCl and 147 in normal NaOH *plus* normal Na_2CO_3 at 100° C. This glass epitomises all the requirements of the laboratory. Stocks are being held by the agents —Messrs. Adair, Dutt & Co., Ltd.

* * *

Announcements :—

The Fifteenth International Congress of Medical Hydrology, Climatology and Geology will be held at Belgrade in October. Further information can be obtained from Prof. Milontine Neskovitch, 3 rue Takowska, Belgrade.

* * *

The Second International Congress of the Scientific and Social Campaign against Cancer will be held in Brussels on September 20–26, under the patronage of their Majesties the King and Queen of the Belgians. Further particulars can be had from the General Secretary, 13 rue de la Presse, Brussels.

* * *

Nature announces that the Third International Congress for Investigation of Light will be held at Wiesbaden on September 1–7, under the presidency of Prof. W. Friedrich, when discussions will be held on the biology and physics of light and treatment of light. Further information can be obtained from Dr. H. Schreiber, Robert Koch Platz 1, Berlin, N. W. 7.

* * *

At the invitation of the Society of Glass Technology, an International Congress on Glass will take place from July 2 to July 11, 1936. The meetings will be held for the most part in

London, while a few will be held also in Sheffield. The arrangements for the technical programme have been made by the International Commission on glass which was set up at Milan three years ago. Further information can be obtained from Prof. W. E. S. Turner, Society of Glass Technology, Darnall Road, Sheffield 9.

* * *

CORRECTIONS.

(1) In the letter: Roonwal, M. L., 1935, 'Fate of the Embryonic Membranes in Insects.'—*Current Science*, Vol. IV, No. 5, pp. 317–18, the insect, the fate of whose embryonic membrane has been described, is *not* the European Migratory Locust, *Locusta migratoria* L., but the African Migratory Locust, *Locusta migratoria migratoriodes* R. & F. Since definite physiological differences have been found between the two sub-species, it is obviously necessary to indicate one's material as exactly as possible.

I am indebted to Mr. B. P. Uvarov of the Imperial Institute of Entomology, London, for this correction.

M. L. ROONWAL.

(2) *Current Science*, 1936, **4**, 656–657.—The contribution "A Modification of Dixon's Constant Pressure Respirometer" should have appeared under the joint authorship of B. N. Singh and P. B. Mathur. Only Dr. B. N. Singh's name has been mentioned. We regret the error.

* * *

We acknowledge with thanks the receipt of the following:—

"Bulletin of the U. P. Academy of Sciences," Vol. 6, Part I, February 1936.

"Actualites Scientifiques et Industrielles," Nos. 219, 249, 250–253, 256–259, 260–263, 265, 292–294.

"The Agricultural Gazette of New South Wales," Vol. XLVII, Part 3, March 1936.

"Journal of Agricultural Research," Vol. 51, Parts 10–11, Nov.–Dec. 1935.

Department of Agriculture, Dominion of Canada, Bull. 2.—"Improved Market Type in Poultry Breeding Stock": Bull. 3.—"Farmers' Business Organization in Canada," 1935.

"The Philippine Agriculturist," Vol. XXIV, No. 10, March 1936.

"The Allahabad Farmer," Vol. X, No. 2, March 1936.

"Journal of the Royal Society of Arts," Vol. LXXXIV, Nos. 4344–4348.

"Biochemical Journal," Vol. 30, Nos. 1 and 2, Jan.–Feb. 1936.

"Journal of the Indian Botanical Society," Vol. 15, No. 2.

"Communications from the Boyce-Thomson Institute," Vol. VII, No. 4.

"Journal of the Institute of Brewing," Vol. XLII, No. 3, March 1936.

"Chemical Age," Vol. XXXIV, Nos. 869–873.

"Journal of Chemical Physics," Vol. 4, No. 3, March 1936.

"Berichte der Deutschen Chemischen Gesellschaft," Vol. 69, No. 3.

"Russian Journal of General Chemistry," Vol. V (LXVII), No. 12.

"Journal de Chimie Physique," Vol. 33, No. 2.

"Experiment Station Record," Vol. 74, No. 2, February 1936.

"Transactions of the Faraday Society," Vol. XXXII, No. 3, March 1936.

"Indian Forester," Vol. LXII, No. 4, April 1936.

"Indian Forest Records—Vol. I, No. 12.—"Entomological Investigations on the Spike Disease of Sandal (26) Coccidæ (Homopt.)"

"Indian Forest Records—Vol. II, No. 1.—Shrinkage studies in Indian Woods I. Effect of high temperature on the shrinkage and moisture equilibrium of wood."

"Forschungen und Fortschritte, Vol. 12, Nos. 7–9.

"The Quarterly Journal of the Geological, Mining and Metallurgical Society of India," Vol. VII, Nos. 3 and 4.

Government of India Publications—"Monthly Statistics of Production of certain Selected Industries of India, Department of Commercial Intelligence and Statistics," Nos. 8 and 9.

Government of India Publications—Indian Meteorological Department, Vol. 6, No. 67.—"Measurement of Vertical Currents in the Atmosphere mainly of Thermal Origin with Pilot Balloons."

"Indian Trade Journal," Vol. CXX, Nos. 1551–1553; Vol. CXXI, No. 1554.

"Marriage Hygiene," Vol. II, No. 3, February 1936.

"The Calcutta Medical Journal," Vol. 30, No. 9, March 1936.

"Medico-Surgical Suggestions," Vol. 5, Nos. 2 and 3.

"Journal of the Annamalai University," Vol. V, No. 2.

"Annual Report of the Calcutta School of Tropical Medicine and the Carmichæl Hospital for Tropical Diseases," 1934.

"The Calcutta Review," Vol. 59, No. 1, April 1936.

"The Presidency College Zoology Magazine," Madras, Vol. 3, No. 5, 1936.

"Review of Applied Mycology," Vol. 15, Nos. 2 and 3.

"Journal of the American Museum of Natural History," Vol. 37, Nos. 2 and 3.

"Nature," Vol. 137, Nos. 3460–3464.

"Journal of Nutrition," Vol. 11, No. 2.

"Canadian Journal of Research," Vol. 14, Nos. 1 and 2 and Index to Vol. 13.

"Journal of Research," National Bureau of Standards, Vol. 15, Nos. 5 and 6.

"Ceylon Journal of Science," Section B.—Zoology and Geology, Vol. XIX, Part 3.

"Science and Culture," Vol. I, Nos. 10 and 11.

"Lingnan Science Journal," Vol. 15, No. 1, Jan. 1936.

"Scientific American," Vol. 154, Nos. 3 and 4.

CATALOGUES.

"Bell's Miscellany," Spring 1936 (G. Bell & Sons, Ltd.)

"New Books in General Literature," Spring 1936 (Edward Arnold & Co., Ltd.).

"Monthly List of Books on Natural History and Science," March 1936 (Wheldon and Wesley, Ltd.).

"Mitteilungen uber Neuerscheinungen und Fortsetzungen, Nos. 1 and 2" (Verlag von Gustav Fischer in Jena).

Academies and Societies.

Indian Academy of Sciences:

March 1936. SECTION A.—H. GUPTA: *On the Numbers of Ward and Bernoulli.* R. ANANTHAKRISHNAN: *Polarisation of the Raman Bands of Water and Deuterium Oxide.* The influence of temperature and the observed polarisation results could be satisfactorily explained by postulating that the liquid state is composed of a large percentage of polymerised molecules (dihydrol) with frequencies 3220 and 3430, and a smaller percentage of non-polymerised molecules with frequencies 3430 and 3600. D. R. DHINGRA, H. L. UPPAL AND K. VENKATARAMAN: *Antiseptics and Anthelminthics. Part II.—A Synthesis of 6-Benzyl-7-hydroxyflavone and 6-n-Hexyl-7-hydroxyflavone.* R. S. KRISHNAN: *Scattering of Light in Optical Glasses.*—The intensity and state of polarisation of light scattered transversely by a series of seventeen glasses of optical quality has been studied with the incident light in different states of polarisation. It is concluded that there exist molecular aggregates of size not small compared with the wavelength of light. B. L. GULATEE: *Gravity Formulæ in Geodesy: Their Precision and Interpretation.* A number of important gravity formulæ are discussed. N. W. HIRWE and M. R. JAMBHEKAR. *Derivatives of Salicylic Acid. Part IX.—Stability of the Sulphonic Acid Group in the 4-Sulphosalicylic Acid. Part I.—Nitration of 4-Sulphosalicylic Acid.*—Sulphonic acid group outside the directing influences of the –OH and –COOH groups cannot be substituted by the nitro group as in 3- or 5-sulphosalicylic acids. B. SUNDARA RAMA RAO: *Studies on the Anisotropy of the Optical Polarisation Field in Liquids. Part I and Part II.*—From a knowledge of the molecular refractivity at different temperatures, the anisotropic constants of the optical polarisation field are calculated in CS_2, C_6H_6 and C_6H_{14}. The polarisation field becomes more and more isotropic with increasing temperature. S. SIDDIQUI: *The Alkaloids of Holarrhena Anti-Dysenterica. Part IV.—The Occurrence of Two Further New Bases in the Bark of Indian Holarrhena and Their Relationship to Conessine and Holarrhimine.* S. SIDDIQUI AND R. H. SIDDIQUI: *The Alkaloids of Holarrhena Anti-Dysenterica. Part V.—Studies in Holarrhimine.*—Methylation, benzoylation and acetylation have been studied. N. W. HIRWE AND M. R. JAMBHEKAR: *Derivatives of Salicylic Acid. Part X.—Stability of Sulphonic Acid Group in the 4-Sulphosalicylic Acid. Part II.—Bromination of 4-Sulphosalicylic Acid.* H. J. TAYLOR AND V. D. DABHOLKAR: *The Tracks of the α-Particles of Thorium and its Products.*—Radiothorium atoms introduced into a photographic emulsion disintegrate *in situ*, emitting five α-particles in succession. In this way "stars" are produced, consisting of five tracks radiating from a point. E. GORA: *On the Theory of Pressure Broadening of Spectral Lines.*

March 1936. SECTION B.—M. K. SUBRAHMANIAM AND R. GOPALA AIYAR: *On the Possible Effect of the Environment on the Cytoplasmic Inclusions in the Oocytes and Oogonia of* Dasychone cingulata, Salmacis bicolor *and* Clibanarius olivaceus.—The remarkable diversity of results obtained by workers on the Cytoplasmic phenomena during Oogenesis in the same animal, is due to variations in the environment (1) seasonal and (2) geographical. P. M. GLOVER AND K. C. CHATTERJEE: *A Preliminary Note on the Bionomics and Economic Importance of* Microbracon Hebetor *Say, A* Braconid *New to North India.*—For the first time. *M. Hebetor* Say is recorded in Northern India and a preliminary description of the behaviour, and economic importance with particular reference to lac cultivation is given. I. FROILANO DE MELLO AND EMERCIANO DIAS: *Plasmodium narayani N.Sp., Parasite of the Fish Otter* Lutra lutra.—A plasmodid of a fish otter, found only in the blood and lung smears, has been recorded for the first time. J. S. PATEL, C. M. JOHN AND C. R. SESHADRI: *The Inheritance of Characters in the Groundnut,* Arachis hypogæa.—An attempt at a genetic analysis of the several characters—chlorophyll deficiency, abnormality, habit, branching, duration, hairiness, anthocyanin pigment in the plant and four seed-coat colours—of the groundnut, has been reported. Thirteen genetical factors are assumed for interpreting the results. M. B. MIRZA: *A New Species of the Nematode Genus* Dermatoxys *from* Lepus ruficaudatus.—The species described differs from the known ones of the genus *Dermatoxys* Schneider, 1866, necessitating the creation of a new species. B. N. SINGH AND G. P. KAPOOR: *Plant Growth in Relation to Partial Pressures of Oxygen.*—The dry matter production at any stage during the growth is the resultant of two variables: (1) the age factor and (2) the factor for oxygen. B. M. JOHRI: *Contribution to the Life-History of* Cedrus deodara *Loud.*—The development of the microspores and the pollen grains of this interesting Indian Conifer has been described. A. SREENIVASAN: *Investigations on the Role of Organic Matter in Plant Nutrition.—Part XI.—Effect of Manuring on the Growth and Intake of Silicon by Dry and Wet Cultivated Rice.*—The beneficial effect of silicate fertilisation in field practice and the rôle of silicon in the nutrition of the rice plant have been discussed. YAJNAVALKYA BHARADWAJA: *On Two Forms of* Hydrurus *Ag. from Kashmir.*—Two forms of Chrysophyceæ have been recorded and described.

The National Academy of Sciences, India:

March 25, 1936.—MATA PRASAD AND B. V. MOHILE: *The Photo-Reduction of Ferric Chloride in Alcoholic Solutions in the Light of a Quartz Mercury-Vapour Lamp.* M. L. ROONWAL: *Sexual Dimorphism and Post-Embryonic Growth in* Dialeurodes dissimilis *Quaint. and Baker* (*Homoptera, Aleurodidea*). M. N. SAHA and A. N. TANDON: *A New Model Demountable Vacuum Furnace.* S. C. VERMA: *Studies in the Family Bucephalidæ* (Gasterostomata).—*Part II.—Description of Two New Species.* JAGRAJ BEHARI LAL: *Chemical Examination of the Fruit of* Physalis Peruviana *or Cape Goose Berry.*

Indian Chemical Society:

March 24, 1936.—DINES CHANDRA SEN: *Studies on Cyclic Thioketones. Part I.—Synthesis of Non-Polymerised Thiocyclohexanone, Thiocyclopentanone and their Derivatives.* N. M. BOSE AND S. R. MAITRA:

Investigation on the Effects of Humidity and High Temperature on the NH_2-content of Different Samples of Rice. DINES CHANDRA SEN: *Studies in the Camphor Series.—Part III.*

Indian Botanical Society:

April 1936.—A. C. JOSHI: *A Contribution to the Embryology and Cytology of* Rivina humilis *Linn.* V. S. RAO: *A Contribution to the Morphology of* Antigonon leptopus *Hook. and Arn.* B. S. NIGAM: *Physiology of Zonation.—Effect of Light and Temperature on Zonation in* Acrothecium lunatum *Wakker.* EDWARD BARNES: *Two Notes on South Indian Strigas.* K. P. RODE: *A Silicified Dicotyledonous Wood* Dryoxylon mohgaœnse *sp. nov. from the Deccan Intertappean Beds of India.* G. N. RANGASWAMI AYYANGAR AND V. PANDURANGA RAO: Sorghum popyrascens *Stapf.* D. P. MULLAN: *On the Seed Structure and Germination of* Acanthus ilicifolius *Linn.* MUKAT BEHARI RAIZADA: *Recently Introduced or Otherwise Imperfectly Known Plants from the Upper Gangetic Plain.*

Meteorological Office Colloquium, Poona:

March 10, 1936.—Mr. A. K. ROY summarised Col. Gold's Presidential address on "Fronts and Occlusions", delivered before the Royal Meteorological Society in January 1935.

University and Educational Intelligence.

Aligarh Muslim University:

The Degree of Doctor of Laws (*Honoris causa*) was conferred on His Excellency Lord Willingdon, Viceroy and Governor-General of India and Lord Rector of the University, at the Special Convocation, held on 22nd March. The Chancellor, H. E. H. the Nizam of Hyderabad, presided.

H. E. H. the Nizam announced a donation of Rs. 10,000 for the construction of a Pavilion in commemoration of Lord Willingdon's visit.

It is understood that Sir Azizuddin Ahmed donated Rs. 10,000 to the Aligarh Muslim University. A similar donation has been made by the Raja of Pirpur.

The Andhra University:

Mr. C. R. Reddy, M.L.C., was elected Vice-Chancellor of the University. The election was held on 28th March.

University of Madras:

Award of Research Degrees.—

D.Sc.—Mr. S. Gopalakrishnamurthy, M.A. Thesis—"Atomic Energy States of Tellurium").

M.Sc.—Mr. N. Kesava Panikkar, B.A. (Hons.) Thesis—"Studies in South Indian Brackish Water Actinarius"); Mr. P. K. Sesha Aiyer, B.Sc. Thesis—"Absorption and Fluorescence Spectra of Organic Compounds"); Mr. T. K. Srinivasan, B.Sc. (Thesis—"Action of Sulphuric acid on Cotarnine; Action of Bromine on Narcosine, &c."); Mr. T. Varahalu, B.A. (Thesis—"Physical and Chemical Studies on Sugarcane Jaggery").

University of Mysore:

1. *Personnel.*—Dr. E. P. Metcalfe, D.Sc., F.Inst.P., Vice-Chancellor, has been granted leave for 27 days from the 5th March 1936, with permission to affix thereto the summer vacation, and Mr. N. S. Subba Rao, M.A., BAR-AT-LAW, Director of Public Instruction in Mysore, has been appointed to be in charge of the office of the Vice-Chancellor, in addition to his own.

2. *Special Convocation.*—A special Convocation of the University was held at Mysore on the 25th March 1936, for conferring the Honorary Degree of Doctor of Laws, on Rajasabhabhushana Diwan Bahadur Sir K. P. Puttanna Chetty, Kt., C.I.E., Retired Member of Council, His Highness the Chancellor presiding.

3. *Recognition of Examinations.*—The University of Calcutta has recognised the S. S. L. C. Examination of Mysore as equivalent to the Matriculation Examination of that University, subject to the condition that the holders of the certificate must be declared eligible by the University of Mysore for joining the University course before they are allowed to join a college under the Calcutta University and that they must also conform to the usual rules of migration.

4. *Election to the Mysore Medical Council.*—In the election held for returning a member from the Faculty of Medicine of this University to the Mysore Medical Council, Mr. B. K. Narayana Rao, B.A., M.B.C.M., M.R.C.S., D.P.H., D.O., Principal, Medical School, Bangalore, secured the highest number of votes.

5. *Meeting of the Senate.*—The Annual Meeting of the Senate was held on the 26th March 1936, at which the annual report and accounts for 1934–35 were adopted and the budget estimates for 1936–37 considered and passed, providing for a grant from the Government of Rs. 10.36 lakhs. A proposal intended to introduce changes in the mode of election to University authorities were vetoed.

Among other decisions arrived at, mention may be made of the following:—

(1) That candidates successful in the M.A. and M.Sc. degree examinations should be classed, the minimum for a First Class being 60% and that for a Second Class being 50%.

(2) That the Government of Mysore be requested to move the Government of India that in recommending candidates for appointment in the Secretariat and other institutions connected with the League of Nations in future, due consideration be given to deserving graduates of this University also, since so far no graduate of this University has been made the recipient of the honour of serving under the League of Nations.

Nagpur University:

At a meeting of the Executive Council of the Nagpur University, held during the last week of March, Sir Hari Singh Gour, Vice-Chancellor, who will be participating in the centenary celebration of the London University in July next, was granted leave of absence for four months. Subject to His Excellency the Chancellor's approval, Col. K. V. Kukday was appointed

Acting Vice-Chancellor, during Sir Hari Singh Gour's absence.

Inter-University Board:

The following among other resolutions were passed at the eleventh meeting of the Inter-University Board, held at Aligarh, which concluded on Wednesday, February 26. Mr. Littlehailes, the Vice-Chancellor of the Madras University, presided:—

That a committee consisting of Mr. R. Littlehailes, Sir George Anderson and the Hon'ble Mr. Justice Khwaja Mohd. Noor be appointed to select two candidates to be recommended for the award of Carnegie Corporation Grants.

That the Universities in India be invited to consider whether it is not desirable to adopt the Intermediate Examination in Science as the qualifying test for admission to the courses of study of Medical Degrees.

That appropriate departments of Government of India be addressed to include: (i) Natural Science in the list of subjects for all the Competitive Examinations from which they have recently been omitted; (2) Philosophy as one of the subjects for the Indian Audit and Accounts Examination, and Ethics and Psychology in the list of subjects for the Indian Police Service Examination.

That the Trustees of the Carnegie Foundation be requested to include Indian Universities in the scheme of the provision of thirty-six Fellowships, intended for displaced German scholars.

That the Government of India be addressed urging upon them the necessity of securing for Indian students, who are granted foreign scholarships, or Fellowships by the different Universities, a definite number of seats without premium in different industrial concerns of the various countries from which supplies are purchased by India, by making suitable conditions at the time of giving contracts.

That the Universities be requested to consider the desirability of including Nautical and Aeronautical instruction in the University curriculum.

That the invitation of the University of Nagpur be accepted with thanks, and the venue of the next meeting of the Inter-University Board be there.

Pandit Amarnath Jha of the University of Allahabad was elected Chairman for the year 1936–37. Dr. J. C. Ghosh of Dacca, Prof. Parija of Cuttack, and Dr. L. K. Hyder, Member, Public Services Commission, were elected to represent the Inter-Varsity Board on the Imperial Council of Agricultural Research.

Reviews.

The Restless Universe. By Max Born. Authorised Translation by Wirifred M. Deans. (Blackie & Sons, London, 1935.) Pp. 278; price 8*sh.* 6*d.*

There is a good stock of popular literature on modern physics in the English language. Jeans and Eddington are almost household words. Entirely new ideas as well as difficult and abstruse subjects have been presented in lucid manner with the discipline of English style by these master minds. Nevertheless Max Born's *The Restless Universe* (authorised translation) may be called a new venture in this line considering the high ambition with which the author sets out and the wonderful manner in which he seeks to realise it. The reading of the book is a first-rate intellectual treat.

The book is divided into five chapters, each of about fifty pages, on the air and its relatives, electrons and ions, waves and particles, electronic structure of the atom and nuclear physics. The author starts with the simplest type of matter, *viz.*, the gas and explains its essential properties by introducing the Kinetic theory of the molecules which are really the main objects of study in the first chapter. The statistical idea is introduced almost at the very start preparing the reader for the shocking surprise awaiting him in the later portion of the work that "all laws of nature are really laws of chance in disguise". After describing how actual beams of molecules can be produced to hit a target and how their number can be measured, the subdivision of molecules, chemically into atoms, their classification, the periodic table of elements are all brought in one sweep and the first step in the journey for the quest of the ultimate source of matter ends. The reader then crosses a boundary into a new realm populated with electrical beings: electrons and ions. The physicists now develop some refined sense organs to feel the existence of, to see and even measure these new creatures. The reader is now acquainted with Wilson Chamber, Geigar-Müller counter, and knows the charge of the electron, its mass and even the highly ethical unitary doctrine of identity of Mass and Energy. Then he comes almost to the heart of the problem. The electronic world often sends messengers to the outside world of ours in the form of radiation and in turn receives such messengers from outside. The mystery then deepens. What is the relation of this messenger to the electronic population?

The messenger, light, plays a dual rôle. While journeying in the outside world it is a wave but in the dealings with the atomic population it behaves as a particle of energy. On entering the realm of electrical charges it can knock out an electron with great speed to the outside world. The dual rôle is then found to be not only a characteristic of the messenger but also of the electron. Electron waves can be actually made visible on the photographic plate. The reader is then reconciled to the idea that matter is wave and wave is matter. The difficult subject of wave mechanics, probability wave and its bearing on the principle of causality are introduced gradually, and the reader learns that to understand the behaviour of the creatures of the new realm of electricity, one has to sacrifice the outside world law of causality which, as the author hints, is probably only a habit of thought.

Then comes Bohr's description of the new world of atoms. The electronic population within an atom is in a mad whirl round a citadel of positive charge called nucleus. This whirl may be described in terms of moving particles which curiously are restricted only to certain discrete paths which can be constructed only by adapting certain processes patented by the German physicist Planck more than thirty years ago. This was really the beginning of the modern quantum theory. Alternatively, a description in which the electrons are divested of their individualities and are regarded as waves in a certain conceptual space is also possible. The waves can only tell us about the odds that an electron will be found in a certain place but it will be quite in vain to think of the motion of the electron with time. Both processes are useful in understanding the observed behaviour of the electronic world but the latter ultimately proves to be more powerful. A host of phenomena previously considered to be unconnected or very imperfectly understood, now find unification within the electronic world of the atom.

The journey across the electronic realm takes the reader first through an outer region which is the region of activity of chemical changes and whence the messengers are responsible for what are called optical spectra. The uplands are populated by electrons having more vigorous motion, and which send out more energetic messengers outside in the form of X-rays. Right up on the top is the citadel called nucleus. This is too strong to be penetrated by the ordinary means of the physicist. The history of the present-day advance in physics is really an account of the attempt by the physicists to storm the citadel.

The last chapter of the book describes the fundamental particles discovered by the bombardment of the nucleus, and the nuclear transformation which is a realisation of the dream of the alchemists of the Middle Ages by modern physicists (but not from a sordid spirit of lucre the author assures us). But here the reader is compelled to stop. The journey remains unfinished. Born's printer was once pleased to compose 'nuclear physics' as 'unclear physics,' and the author admits that the printer was not far wrong. For, after a successful journey over many an unknown and difficult region, the reader is now left on the citadel, the deepest centre of the material universe with the mystery wall still rearing its head proudly before him while off and on missiles sent from outside, or some of the inner population mysteriously leaking through the wall bring very valuable information to the physicists. But the reader finds there is no solid ground underneath him anywhere. Starting from the outside world, looking into the sub-world of molecules shows them to be in continual motion colliding with one another. The electronic world inside the atom is in a mad whirl which becomes wilder and wilder the deeper one penetrates into the atomic layers. Besides, to be able to understand the workings of these lower sub-worlds one has to sacrifice his cherished outer-world ideas of wave and matter and even of casual principle. But the quest goes on and it is earnestly hoped that the scientists' love of truth will one day put him in possession of the secrets of matter, so far as it may be within the grasp of the human mind.

A novel feature of the book is the film and there are seven of them. I confess I have not been very successful with some of them but realise they will prove interesting to many, specially to the young readers. There are a few inaccuracies in the book, for instance on page 45 the proportion of hydrogen to oxygen has been inverted and the same defect occurs again on page 47, line 7.

N. R. S.

Experimental Atomic Physics. By G. P. Harnwell, PH.D. and J. J. Livingood, PH.D. (International Series in Physics.) (Messrs.

McGraw Hill Publishing Co., London. 1933.) Pp. 472. Price 30*s*.

This volume of about 450 pages covers in a general way the whole field of modern physics considered from the experimental standpoint. The following are the main chapter headings:—(1) The Velocity of Propagation and the Pressure of Radiation, (2) Black-body Radiation, (3) The Atomicity of Matter and Electricity, (4) The Ratio of Charge to Mass of Electrons and Ions, (5) The Wave Aspect of Matter, (6) Thermionic and Photo-electric Effects, (7) Line Spectra, (8) Atomic Energy States, (9) X-Rays, and (10) Radioactivity. There are two very useful appendices, one dealing with instruments for measuring small currents and potential differences and the second describing vacuum technique. The treatment is sufficiently detailed to give the student a grasp of principles and at the same time a very fair idea of the technique of the fundamental experiments on which modern physics is based. The volume is to be heartily recommended to Honours students in Indian Universities and to their teachers who desire to have a text on which to base their lectures.

C. V. RAMAN.

Physikalische Methoden Der Analytischen Chemie. By G. Scheibe, H. Mark and R. Ehrenberg. (Akademische Verlagsgesellschaft, Leipzig, 1933.) Erster Teil. Pp. 388. Price Unbound 34 RM and Bound, 36 RM.

This volume deals in an authoritative and useful manner with spectroscopic and radiometric methods used in analytical chemistry. The authors are G. Scheibe, H. Mark and R. Ehrenberg who deal respectively with the use of the spectroscope, with X-ray methods and with the use of radioactive indicators for the purposes of analytical chemistry. As might be expected from the fact that the authors are specialists in the fields dealt with by them, the treatment of the subject is clear and thorough. Scheibe's article includes an account of elementary spectroscopic theory, the production of spectra, apparatus for recording and measuring spectra, and a detailed account of both qualitative and quantitative analytical methods with the aid of emission and absorption spectra. Mark's article similarly deals with the production of X-rays, X-ray spectroscopes, the systematics of X-ray spectra and with qualitative and quantitative analysis with the aid of emission, absorption and fluorescent X-ray spectra. Ehrenberg's article is the shortest of the three and is of special interest at the present time owing to the recent great development of radio-chemistry. The book is fully illustrated and contains extensive tables which should go far to make it a very useful handbook in the laboratory besides being an excellent text for theoretical study. The volume should be in the hands of every worker interested in the modern developments of chemistry.

C. V. RAMAN.

Electrical Engineering Economics. By D. J. Bolton. (Chapman & Hall, London.) 1935. Pp. 365; Price 21*sh*.

Engineering may in some respects be considered a branch of economics including mainly the science of utilising materials in the most economic manner consistent with safety.

The average engineering graduate in this country appears to possess little, if any, knowledge of Engineering Economics. In these days of fierce competition it is very necessary that more attention be paid to this important subject and Mr. Bolton's book should prove a most admirable treatise for arousing the interest of the student in economics and providing a good foundation to his education as an engineer. To the more experienced man it would be of value as a reference book. A feature of the book is the treatment of economics of consumption as well as production.

Part I deals in a clear and convenient manner with general economic principles involving capital, interest, depreciation, sinking funds, etc., which should be of particular value to the student. Depreciation is a complex and much discussed subject to-day and its application in actual practice, is more a question of policy and judgment than of accounting or mathematics. The chapters on depreciation discuss the various causes of depreciation, loss of value, and the fact that the physically useful life may be and usually is shortened by obsolescence, inadequacy and other factors. This together with the short chapter on economic productivity should awaken the interest of the student and engineer sufficiently to warrant a deeper study into such important subjects.

Chapter VIII is of special interest as it discusses the economic desirability in some

cases of operating machinery underloaded. This of course is difficult of application when motors of different manufacturers are compared as their design characteristics, tolerances for heating, etc., do not correspond, while the cost of losses as discussed later must be applied with caution.

Part II is mainly devoted to losses and their economic significance. Annual costs are an elusive study. Electrical engineering, economic formulæ and principles are generally applicable to generating plants operated by steam or oil engines where the expenses of generation are a big item in the "all in" cost of a unit. In such cases higher capital expenditure to reduce losses is more often justified than in the case of hydro-plants. The economic treatment is somewhat different. In the one case a definite and tangible value can be applied to the losses of a system having a steam or oil engined station, but it is not so easy in the case of a hydro-electric system. Larger losses are usually permissible unless it can be shown that such power could be sold.

Again in applying such formula, particularly maxima and minima, considerable judgment is usually necessary to decide if the mathematically correct result is a practicable proposition. Formulæ for the most economic penstock line for instance, may often give a thickness too small to be mechanically practicable or thicker than permitted by standard practice. Generally speaking, the use of economic formulæ provides excellent training for the young engineer but they should only be applied in practice by experienced engineers who are able to understand the practical limitations involved.

Part III deals with electricity supply economics. Two chapters are devoted to an excellent discussion on power factor economics and contains much useful information on the causes and effects of bad power factor together with corrective methods and their costs. Bonus, penalty and K.V.A. demand tariffs are also explained.

The three chapters on tariffs should convey a clear idea of the factors upon which tariff structures are based and of the modern methods of charging. A brief note of the comparative merits of the "step" and "block" methods of charging on a sliding scale might have been included.

The book ends with a short chapter on some general notes on power supply and a useful appendix.

Taken altogether, a very useful and informative book which can be recommended.

H. G. H.

Introduction to Electric Transients. By Edwin B. Kurtz, and George F. Corcoran, (John Wiley & Sons, Inc., New York. Chapman & Hall, Ltd., London.) 1935. Pp. 335. Price 22*s*. 6*d*.

The study of transients is one of the most fascinating in engineering and physical science, perhaps because it affords extensive applications of differential equations to physical problems, the mathematics involved being, at the same time, of a comparatively simple order, the result is that the subject is a favourite with advanced students.

The first thing one notices about the book under review is that Heaviside's Operational Methods are used in addition to or as supplementary to the conventional solutions. This is a very valuable feature indeed as it enables the student to become familiar with this very interesting and useful method of solution and also to compare this method with the conventional method of solution. At the same time the book can be read, if desired, without paying any heed to the operational solutions which are alternative.

The book is divided into two main parts, *viz*., D. C. and A. C. transients and has an appendix on the mathematics employed in which the above is included. This is particularly convenient for electrical engineering students.

The method of treatment is what many people regard as the ideal teaching method, *i.e*., the physical conception of each problem is stated first, this is followed by the mathematical analysis and then by the verification by the oscillograph.

It is claimed by the authors that the subject of "power transients" is given prominent place in the text as well as in a special section in Chapter X, but the examples given are on the whole very poor examples of power transients and the more important aspects of these are not touched on at all. Most of the examples given are on ordinary small laboratory apparatus.

The book, which is very well produced, affords a very interesting, easily read and instructive introduction to transient phenomena and in addition serves as a method of thoroughly learning some of the different equations which are of utmost importance to the engineer and can be strongly recommended.

K. A.

Theorie der Elektrizitat: A New Edition of M. Abraham's work. By R. Becker. Vol. I.—Einführung in die Maxwellsche Theorie der Elekrtizität mit einem einletenden abschnitte über das rechnen mit vektorgrössen in der Physik. Tenth Edition. (B. G. Teubner, Leipzig and Berlin, 1935.) Pp. 265. Price 14-50 RM; Vol. II.—Elektronentheorie. Sixth Edition. Pp. 397. Price 17 RM.

New editions of books which have become classics on the subjects concerned are welcome indeed, for such editions not only retain the spirit with which the old classics were written but also present the newer ideas, resulting from the deepening of the classical foundations. The work on Maxwell's theory of electricity by Föppl was thoroughly revised and published by M. Abraham and this work called as *Abraham-Föppl* became a classic and is well known among all the students of electro-magnetism. *Abraham-Föppl* underwent as many as seven editions in the life-time of Abraham, a fact, which bears ample testimony to the great eminence of the work. The new editions of Abraham's work by R. Becker, while maintaining all the important features of Abraham's work, also include some of the recent developments in electron theory presented by Becker himself.

In the first volume the student is introduced to the theory of vectors and vector fields. A masterly exposition of the thermodynamics of field energy is also given in this volume. The second volume begins with a chapter on the general foundations of electron theory which contains a section on the determination of the elementary charge by what is called the "Schrot effect". The chapter on the electron theory of metals contains the earlier views of Drude and Lorentz and also the newer conceptions of Sommerfeld based on the Fermi statistics. This volume also contains a fair account of both the special and the general theory of relativity and their relation with the electromagnetic field. The last chapter in the volume is on the theory of radiation based on the quantum of action.

Becker's edition was published before the announcement of Born-Infield's work on electrodynamics. We venture to suggest that the inclusion of an account of this theory in a later edition would be most desirable.

No effort has been spared by the Editor to make his editions useful to the teachers and students alike. The number of diagrams has been increased many-fold and this will assist the students in obtaining a vivid comprehension of the text. A section on problems of great physical interest has been included and their solutions also suggested.

Becker should be congratulated for bringing out these new editions of Abraham's work which will undoubtedly prove invaluable to students and teachers. We have no hesitation in recommending these two volumes to all those interested in electro-magnetism.

N. S. N.

Fluorescence Analysis in Ultra-Violet Light. By J. A. Radley, B.Sc., A.I.C. and J. Grant, Ph.D., F.I.C. (Chapman & Hall; London.) 1935. Second Edition., Pp. 326. Price 21 shillings.

The book is one of the series of monographs on applied chemistry edited by Dr. E. H. Tripp. It contains two parts; the first part deals with the theory and technique of fluorescence analysis. Here, the authors discuss briefly the production of ultra-violet light and the method of analysing fluorescence both qualitatively and quantitatively. The various types of lamps and filters that are now in use are discussed and their advantages and disadvantages are pointed out. The authors are of opinion that "the varying results sometimes obtained by different workers for the same substance are often due to lack of precision in defining the technique". Research workers in this line will be in entire agreement with the authors of this book, for the importance of the method that is employed for the analysis and the pitfalls that are to be taken care of are well known. On the whole, this part of the book has been very well written and will serve as a useful guide to those workers who are interested in this subject.

In the second part, the authors give a large number of instances in which fluorescence analysis has been used for both pure and applied science subjects. Here, they had a difficult task to perform, for more than 800 papers had to be summarised. The result has been that information given in some cases is rather scanty. The research workers, however, will find a full list of references at the end of each chapter dealing with different subjects. Finally it may be said that, as far as we know, this is the only book in English language on the

subject of fluorescence analysis and that the appearance of its second edition within such a short time shows how much it has been in demand.

K. A. C.

Wireless—Its Principles and Practice. By R. W. Hutchinson: third edition, xii + 316 pages with 224 figures. Published by the University Tutorial Press. Price 3*s*. 6*d*.

This book obviously meets a real need: or it would not have gone through three editions and some ten impressions between December 1932 and November 1935.

It is expressly meant for the growing army of those who are interested in radio but whose knowledge of mathematics and physics is strictly limited.

In simple and straightforward language, the author deals with the elements of electrical theory and continuous and alternating current circuits, some of the methods of generating electromagnetic waves and the phenomena of wave travel in the earth's atmosphere. More than half of the book is devoted to the numerous types of thermionic vacuum tubes and the different circuits of a modern radio receiver in which they are used. The examples are of tubes of British make. There are also short descriptions of the chief features of the battery, all-mains and superheterodyne types of receivers and of small transmitters. The last chapter deals with the elements of television and of the cathode ray oscillograph.

It will be gathered from the above that the author has endeavoured to make the book up-to-date. The language is everywhere lucid and brief, and suitable for the class of readers for whom it is meant. The numerous excellent illustrations are very helpful.

The price is quite moderate and the book can be recommended in every way to the beginner and the amateur of radio.

R. F.

A Class Book of Magnetism and Electricity By H. E. Hadley. (Macmillan & Co., London, 1936.) Pp. x+512. Price 6*s*. 6*d*.

The author of this book needs no introduction to the students of secondary schools as they are all familiar with his text-books. The present publication intended for students of the Intermediate College comprises a somewhat advanced treatment of Magnetism and Electricity.

The volume begins with a chapter on the fundamental properties of the electric current and is followed by a chapter on some of the practical aspects of magnetism with which every reader ought to be familiar. In these two chapters the author gives the students a rough outline of the subject and introduces him into the various topics, which are more elaborately dealt with later. Theoretical considerations of the various properties of the electric current and magnetic fields are introduced and are amply supported by numerous numerical examples, which enable the student to acquire a thorough and comprehensive knowledge of the subject-matter. The addition of "Historical Notes" at the end of each chapter, will further give the student a chronological account of the theories and principles described; starting from the earliest conceptions of the ancient scientists, the author has chronicled the achievements of the scientists of the succeeding ages. A few chapters towards the end deal with many of the modern practical applications of magnetism and electricity, such as radio-activity, broadcasting, talky-films, television, etc., which have proved so inscrutable to the lay reader.

The book is invaluable not only as a class book to those students preparing for the Intermediate Examination, but also to every literate reader who is desirous of getting an easy and eminently readable introduction to the study of a branch of physics of wide interest on account of its extensive and rapidly increasing practical applications.

The treatment is elegant, simple and always to the point. The book is copiously illustrated and the addition of answers to numerical questions and an index, enhance the interest and usefulness of the publication. The get-up and printing of the book are of the traditional excellence of Messrs. Macmillan & Co.

H. L. N.

Indian Zoological Memoirs. V. Herdmania. By S. M. Das, D.Sc. (Lucknow Publishing House, Lucknow, 1936.) Pp. x + 103. Price Rs. 2.

The fifth of the series of the memoirs on Indian Zoological types deals with an account of the common Monascidian of the Indian seas, *Herdmania pallida*. The introduction includes the classification of Tunicata (after Garstang) which should prove useful to all students of the group. An account of the Bionomics and distribution of the genus is given which shows that it enjoys almost universal distribution and is represented in

the Indian seas by *H. pallida* and *H. ceylonica*. Of these, the former is the more common and the memoir deals with all the systems of organs in great detail. The figures are all original and amply illustrate the descriptions in the text. The high standard set by the earlier memoirs of the series is maintained by the book and it will doubtless be a valuable guide to students in many colleges in India, as well as a reference volume of considerable importance to workers all over the world.

Library Administration. By S. R. Ranganathan. (Published by the Madras Library Association.) Price 12/6.

The author himself says in the Introduction, "This is not a book to be read through like the *Five Laws of Library Science*. It is on the contrary a most prosaic manual full of details." The claim that is made for the book is that it is a reference work capable of guiding the Library Staff to discharge their duties "with highest possible accuracy, greatest promptness and economy". The author says that this should not be treated as a manual to fit every kind of library, but only as giving certain "patterns that can be varied according to local conditions".

Any administrative manual must have as its ultimate end the inculcation of fundamental and basic principles that govern the administration of the particular office, and rules and regulations must be so devised as to keep afresh these general principles in the minds of the staff responsible for the working of it. The accuracy and promptness in the observance of such rules will ultimately tell on the quality of service and the reputation of the office. Doubleday, in his *Manual of Library Routine*, says: "Working methods have to be carefully studied: their details have to be carefully comprehended, rules and regulations should be learnt and the allotted duties should be discharged with goodwill, interest and zeal. This and this alone is the royal road to success."

If the general principles are to be thoroughly grasped by the Staff, it is absolutely necessary that they must be of a fundamental nature, and as brief as possible. An undue elaboration of mechanical rules and devices for working methods, may foster in the minds of the Staff a love of red tape and fascination for administrative routine, and blind them to the real responsibilities of their position.

The chief defect of the book under review is that the rules for any section are too many, too minute and detailed and the whole book is 'over-weighted with details' (to use the language of the Introduction)—'details' which a Library Assistant, who is newly posted, can hardly be expected to master. It is a hard task even for Librarians to wade through the numerous chapters, covered with too many details and unnecessary amplifications of rules of working methods. One would wish that the author had left some of the minor points to the intelligence and resourcefulness of persons concerned in the several departments.

Obviously, the book, dealing with an infinite number of rules and regulations, is useful only for Libraries having at least a few dozens of members to man their staff, and several heads of sections to supervise their work. It can have no application to Libraries having a small staff and fewer number of books, like the School and College Libraries in India. Probably, the administrative machinery evolved may be found quite suitable and appropriate to the Libraries of the type of the British Museum and the Bodleian.

The book contains three parts. The first part is entitled the 'Groundwork'; the second is called 'Distinctive Library Functions'; and the third is named 'General Office Functions'.

The first part describes the general principles of administration and is simple in treatment. In the second part, there are eight different chapters covering subjects like 'Book Selection', 'Book Order', 'Periodical Publication', 'Accession Section', 'Technical Section', 'Counter Section', 'Reference Section' and 'Shelf Section'. The third part deals with twelve different topics, *viz.*,—'Committees', 'Staff Section', 'Staff Council', 'Over-seeing', 'Publicity Section', 'Finance', 'Accounts', 'Records', 'Correspondence', 'Printing', 'Binding', and 'Stores' and a chapter is devoted to each of these.

Each of these chapters contains the following headings—Planning, Job Analysis, Routine, Oversight, Correlation, Time Scheme, Forms and Registers—the same subjects are discussed again and again in different view points with minuteness and detail.

In the chapter on Book Order, a few suggestions regarding the sources for finding the addresses of the numerous Publishers would doubtless have enhanced the value

of the publication. In the Periodicals Section, the three-card system is advocated, which may be resorted to when the periodical publications range over a thousand, and this can have no application to smaller libraries. The author's advice to deal directly with the Publishers of periodicals is a wholesome advice to all Librarians. The work of entrusting them to an agent, with a view to effect a small saving, would result in irregularities in service and land the authorities in financial loss. The author feels, correctly that, in the revision of periodical publications, the Committee should treat the Librarian's views with consideration.

Instead of leaving the acceptance of all gift books to the individual discretion of the Librarian, it would have been better if a few rules had been framed for accepting them. The idea of an Indemnity bond mentioned in the chapter on Counter Section for lost tickets may not be agreeable to all Librarians. While it may check all unauthorized borrowings on lost tickets, the rule will work as a hardship on innocent users of the Library who might happen to lose their tickets by accident.

The chapter on Reference Work is well planned and written. It can have no application to School and College Libraries in India.

One would wish that the author had given suggestions for proof correcting in the chapter dealing with Printing, in Part III. The chapter on Binding is fairly exhaustive and sufficiently adequate.

All the subjects of day-to-day administration are very minutely and patiently described with great care and accuracy. One would only wish that the numerous details had been omitted and the book had been made readable and attractive like all other books on the same topic. There is no rule to the effect that books on Library Administration should not be read through and afford real pleasure in the grasp of the fundamentals of administration.

K. N.

Forest Research in India, 1934-35. Part I. The Forest Research Institute. (Manager of Publications, Delhi, 1935.) Pp. 89. Price Re. 1–8–0 or 2*s*. 6*d*.

This official publication summarises the work done during the year 1934–35 at the Forest Research Institute, Dehra Dun. A general review is followed by five chapters, each dealing in turn with the Silvicultural, Botanical, Entomological, Economic and Chemical Sections of the Research Institute.

Within the limits of so concise a publication, one could scarcely expect little more than a mere cataloguing of the different problems tackled. To the student who is specially interested in any of these, there are the Institute publications, a useful list of which is given as Appendix II at the end of the volume.

The admirable range, quality and quantity of the work turned out by the Dehra Dun Institute is at once an eloquent plea and a justification for the multiplication of such institutions in India. Many Forestry problems, while important, have no more than local significance, and even otherwise, a first-hand knowledge of local conditions is a *sine qua non* in this type of research. And in a country of continental dimensions like India—encompassing as it does many climes and types of forests—this need is all the greater. And a single Forest Research Institute like the Dehra Dun Institution is like a "light which makes the darkness visible". The ideal would be a central co-ordinating agency with different regional investigation centres on the model of the Imperial Institute of Agricultural Research. May the Dehra Dun Institute with its fine traditions and record of achievements prove to be such a co-ordinating agency!

The book is printed (as can be seen from the water-mark) on paper manufactured at the experimental plant of the Institute. It is curious that this fact finds no mention in the book itself.

EMMENNAR.

Sulphitation of Lac. By R. Bhattacharya and Lal C. Verman. Technical Paper No. 6. London Shellac Research Bureau. London. Jan. 1936. Pp. 20.

That lac can be dispersed in aqueous solutions of sulphurous acid or alkali sulphites and bisulphites is the latest discovery of the Indian workers on lac stationed at Teddington. The stability of the solution is secured by the addition of anti-oxidants like glycerol and ethanolamine which inhibit the oxidation of sulphurous acid. The possible chemical reaction between the lac and sulphurous acid is stated to be mainly the addition of sulphurous acid or bisulphite to oxygen atoms which exist between pairs of carbon atoms, with the formation of oxonium compounds.

The sulphited lac resin has a higher iodine value and there is also a definite increase in its saponification value. From the practical point of view the coatings of sulphited lac on baking, yield films which possess greater adhesion, flexibility and hardness while even air-dry films resist dilute alkalies, acids and ordinary solvents.

Shellac is used considerably as a thermoplastic binder in plastic moulding; the incorporation of fillers by the "dry" hot process consumes considerable power in grinding and mixing operations and the employment of alcohol for this purpose is expensive. It is suggested that the aqueous dispersions of lac in sulphurous acid offer a suitable and inexpensive medium in which fillers and fibres can be intimately incorporated. The sulphited lac is coagulated or caused to precipitate on to the filler, thus ensuring an extremely uniform distribution of the binding material. It should, however, be added in this connection that this principle has long been adopted in the course of the work carried out at the Indian Institute of Science, employing aqueous dispersions of lac in sodium carbonate which are often bleached with hypochlorite when a pigmentation of the moulding powder is desired.

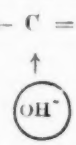
But the great merit of sulphited lac from the point of view of moulding appears to be the fact that the product is brought to an advanced stage of polymerisation; and its softening point is raised to about 130° C. The time of "after curing" is therefore shortened and the additions of accelerators are found to be unnecessary.

M. S.

Errata.

(1) Vol. IV, No. 9, p. 650, under the rational constitution of formic acid,

Read



Ray and Sarkar

for

Ray and Sarkar

(2) On page 767, under 'Recent Advances in Sanitary Science,' line 1 (first column) should read thus: "The following is the *abstract* of an address.....".

397-36.—Printed at The Bangalore Press, Bangalore City, by G. Srinivasa Rao, Superintendent, and Published by B. N. Sastri, M.Sc., A.I.C., A.I.I.Sc., for the "Current Science" Board of Editors, Indian Institute of Science, Hebbal Post, Bangalore.